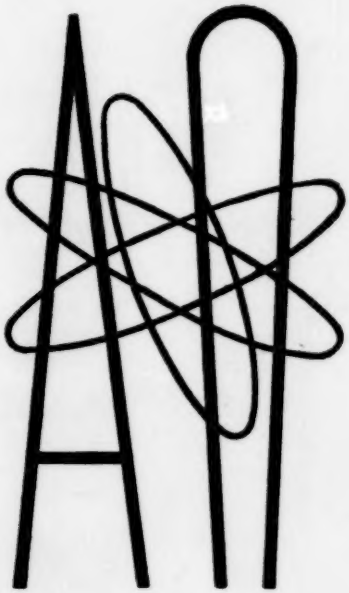
the christian SCHOLAR



Cosmic Encounter: christian faith and natural science

Donald H. Andrews / Michael Foster / Harold Schilling
Mary C. Rose / Henry C. Torrey / Arnold S. Nash
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Volume XLI Number 3 September 1958

THE CHRISTIAN SCHOLAR

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National Council of the Churches of Christ in the United States of America

THE CHRISTIAN SCHOLAR

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THE CHRISTIAN SCHOLAR is a journal devoted to the exploration of Christian Faith and thought in relation to the whole range of the intellectual life and to the total task of higher education in our time.

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THE CHRISTIAN SCHOLAR is closely associated with the *Faculty Christian Fellowship*, a community of persons in academic life whose concern is to relate the insights which arise from their Christian Faith to their teaching and their subject matter fields. The FCF can further be described as a conversation among all members of university life who take their work seriously, whether or not within the Church, to encourage re-examination of the Christian Faith in relation to the competing world-views.

Both *THE CHRISTIAN SCHOLAR* and the *Faculty Christian Fellowship* are departments of the Commission on Higher Education of the National Council of Churches. The purpose of the Commission is to develop basic philosophy and requisite programs within its assigned field, to awaken the entire public to the conviction that religion is essential to a complete education and that education is necessary in the achievement of progress, to foster a vital Christian life in college and university communities of the U. S. A., to strengthen the Christian college, to promote religious instruction therein, and to emphasize the permanent necessity of higher education under distinctly Christian auspices.

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The Editor's Preface

The suggestion that religion and science bear a relation to one another has traditionally served the role of setting off heated debate. It recalls the entire succession of clericalistic and intolerant positions the Christian Church tended to take toward the beginnings of early modern science. It brings to mind certain traits in the Christianity of various periods in recent centuries which assumed that doctrinal decisions could fully respond to scientific questions. Even today, among some circles, such a suggestion leaves the impression that science is to be stifled anew and that scientists are threatened by the pressure of cherished and pre-conceived ideas which are not submitted to the tests for scientific truth. There can be little doubt that the memory of Western man has had deeply implanted upon it "the warfare of science and religion." Equally important, therefore, is the triumph of the sciences, especially the degree to which they are free to determine their own questions and to arrive at their own conclusions by their own procedures. By hindsight we now know moreover that the establishment of this freedom for the sciences has spilled over into all the other academic disciplines. They all claim their autonomy on grounds which served to establish such autonomy for the sciences.

Does this then mean that religion and science bear no continuing relation to one another? Does it mean that the dialogue between Christianity and the natural sciences has ended or that there is nothing left to talk about? Must we conclude that the initial suggestion of a relationship had only one dimension — namely, that the attempt on the part of various traits of the Church's life to dominate science and that with the failure of this attempt any other relationship which might have been conceived is ill-founded? We must admit that these questions are often treated from the standpoint of only one academic attitude. They are often answered affirmatively — the relation is assumed to be dissolved, the conversation ended, the Church has "lost" and science has "won" — and the attempt to re-establish connections or reopen the dialogue is doomed from the outset. What the Church represented when the warfare was at highest pitch is what the Church is! And what the sciences triumphed in is all that science means!

But this is, according to many scholarly indications today, not the whole story of the relation science and Christianity bear to one another. To be sure, it is part of the story, and there are some dismal chapters for the Church in that story. It is also part of the story for the sciences, and there are not a few scientists who sense embarrassment by the claims often stated in terms of the warfare in their behalf. It appears however that today once again, as in some other selected moments of intellectual history, there are those who have accepted the end of the period of warfare and have already begun to write new chapters in a positive relationship. There are those who, as historians, are going back over the heritage of the sciences and are finding that the soil was prepared for them by basic Christian af-

firmations, though this soil had at times to be tilled by scientists outside the Church and even against the Church. There are others who, as philosophers and scientists, find that the very freedom so zealously fought for and cherished is rooted in foundations of human and intellectual freedom which lie deep in the Christian tradition. Still others, among the working scientists, look to their ancestry in Christianity and to a living Christian faith for assistance in understanding the peril and predicament to which mankind has been brought in our time, in part at least by the results of their work. Basic historical research, intellectual reconstruction, and realism about this moment in human history combine to make our initial suggestion of a relation between science and Christianity a new possibility today.

This is the immediate background of the current issue of *The Christian Scholar*. For the most part it is the work of scientists themselves, even at the planning stages. And it attempts to set forth certain limited aspects of the on-going dialogue today between Christian faith and the natural sciences. In some of the articles and reviews, the terms and conditions of the dialogue are set forth; in others, the actual dialogue is carried on; and in still others, the limitations of the relationship are outlined. But throughout one senses the seriousness with which the issues are approached. It is a seriousness born of the dual assumption that the issues addressed here are critical for the individual scientist who is at the same time a Christian man, and they are important as well within the community established among scientists and within the Church. The contemporary world in terms of the images of men and ideas of truth is a world shaped largely by the work of the modern sciences. It is in this world that the Christian and the Church are called to live, to bear the Gospel and their witness to it, and to serve to the glory of God.

The problems to which the Christian faith is addressed are those which give attention both to the external world and to the internal condition of man. This does not mean that the Bible is to be conceived in part as a scientific textbook and in part as a classical source for psychological theory. It means rather that the transformation which lies behind the story of redemption is complete; it has to do with God and man, and with man, his fellow creatures, and the world. The world and everything in it is asserted first of all to be God's created order, and this whole realm of nature, even its inmost secrets, is related to man as in part legitimate for investigation. Indeed to rejoice in the contemplation of the work of God has been seen by some to imply the sacred duty of scientific work if undertaken in an attitude of reverence and with a desire not to distort the truth of God's reality by human prejudice.

Such an idea of nature was itself of fundamental importance in the kind of attitude which made it possible for investigation to go directly to the world for knowledge and not to remain subject to the dictates of what was believed to be natural by the traditions of reason. A similar freedom came with the attempt some made to apply the liberty they

learned from reading the Scriptures to their reading of the book of nature. By the seventeenth century there were those Puritan scientists who regarded science as an ally of true religion. But the foundations of their work were laid in a freedom which derived from their faith that truth was to be found in revelation in Scripture and nature. Later still, the exactness of scholarly studies of the Bible to determine rightly what its message was, suggested a similar exactness in dealing with the world of nature. Therefore, rather than following the Enlightenment's principle that freedom leads to truth, the Puritans and those who followed their lead asserted that Truth leads to freedom — the very freedom essential for investigation and knowledge.

Here the Christian faith turns in its focus upon the conditions of inward freedom — freedom from the idolatry of systems as well as the claims of authority — freedom for the pursuit of knowledge. This positive freedom, to which Luther referred in his famous essay, is a basic precondition for scientists and for all who participate in the intellectual endeavor. It is the freedom which must be theirs if they would present reality truly and not distort it to fit any particular subjective preconceptions or external authorities. The question the Christian puts in the dialogue with the sciences is the question of the source of such freedom. What has it to do with the freedom for which Christ has set us free? This involves the need of analyzing the nature of the freedom of redemption in contrast with the bondage which comes with the desired escape from freedom. The obstacles to freedom may not be only those which are found in outward institutions but in the tendency of all men to refuse to be contented with God alone and who want other gods beside him. Loyalty to God alone as the way of human freedom is a Christian way of putting this relation of faith to freedom. Has this freedom a relevance for the natural scientist as well?

We wish to call your attention to a special issue of *The Christian Scholar* which has just been published, containing the addresses and reports for the second quadrennial Convocation of Christian Colleges. This Convocation was held at Drake University, June 22-26, 1958, and is a signficant landmark in the continuing task of facing the problems of higher education from the perspective of the Christian Faith. Under the theme, "The Vocation of the Christian College", the delegates worked in six study sections and heard excellent addresses from leading educators of North America, England and India. The complete table of contents of this special issue is reproduced on the overleaf (page 346). It may be ordered in any amount at the rates indicated. Subscribers should note that they will *NOT* receive the special issue as part of their subscription; it must be purchased separately. But we are making it available to subscribers at the reduced price of $1.00 for one copy only. A postpaid order form will be found elsewhere in this issued for your convenience.

THE CHRISTIAN SCHOLAR **Special Issue (Autumn 1958)**

containing all addresses and reports from the second quadrennial Convocation of Christian Colleges — a convocation of representative persons from the Protestant colleges in the United States, for the dual purpose of affirming the vocation of the Christian college and studying its role today.

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The Challenge of the New Cosmology

Donald Hatch Andrews

Certainly among the most exciting scientific events of the last quarter century has been the discovery of the two distinct chains of evidence which many believe point toward a "creation" of the universe about five billion years ago.[1] It is especially striking that one line of evidence comes from the realm of the smallest objects we know, the nuclei of atoms, and the other comes from the largest, the galactic nebulae.

As a chemist, I have been particularly intrigued by the way in which the study of radioactive atoms throws light on the early history of our universe. Everyone now seems to agree that collections of these atoms behave like little clocks which were all "wound up and started ticking" initially at a single point in time, a point reached by counting back roughly five billion years. In view of this you can understand my excitement when concurrently but independently, astronomers reported similar evidence from the realm of the almost infinitely large, the distant nebulae. For the change in the color of light coming to our earth from the remotest parts of the universe was interpreted as showing a rushing apart of all the stars; and from the rate of this spatial expansion, it was possible to estimate how long ago it was when the rushing-apart first began, when all the stars were "together at a point;" and surprisingly this turned out to be about five billion years ago also. This suggests that long ago everything started happening *all at once* at a time which calculates out to be essentially the same whether measured by evidence from the very small or from the very large. And to such an initial event it is logical to apply the term "Creation."

The Breadth of the Problem

Of course it is immediately clear even from the elementary summary which I have just given that here is unfolded an area filled with possibilities for a new understanding of some of the oldest and most fundamental questions which have confronted the human mind. But it is equally clear that here is also a tempting field for hasty and ill-considered speculation. For the trouble is that in approaching a problem like the nature of creation, even in interpreting just the scientific evidence, the strictly scientific point of view alone is not enough. We need to bring to bear a number of intellectual skills, not only that of the scientist but those of the philosopher and the theologian as well. Inevitably we are dealing in this problem with concepts so basic that the reference-frame of science in the narrow sense is not ade-

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1. G. O. Jones, J. Rothblat, and G. J. Whitrow, *Atoms and the Universe.* New York: Charles Scribner's Sons, 1956.

quate to give them significant meaning. Indeed scientists are already objecting in just this connection that "creation" itself is an unscientific term. If this initial event is creation, they say, is it creation *ex nihilo* and, if so, what does it mean to say that something is created out of nothing? On the other hand if this initial event is only a boundary to knowledge, a point prior to which things may have happened, but things about which we can never have any information, does that imply a kind of rhythmic existence of the universe, pulsing in cycles from pre-eternity to post-eternity, but with human knowledge and observation limited to only one pulse? And one school of cosmologists asks whether it is not more logical to reject the initial-point idea and to postulate continuous creation taking place about us all the time.

In both asking and in trying to answer questions like these, scientists are clearly moving out of their familiar discipline. But their need for help points to a further problem, namely that it is difficult for philosophers and theologians to grasp, evaluate, and interpret scientific evidence; just as it is difficult for the scientist to pursue the philosophical and theological implications of this evidence. However, I can't see any hope of progress in our thinking about these questions unless we all can make a joint attack on them; and I believe that for such an attack each of the three disciplines mentioned is just as essential as the others.

It is for the purpose of stimulating this kind of joint effort that I want to set forth a few aspects of this "creation" problem, aspects necessarily more suggestive than definitive. Especially I want to present the problem in the light of the even more revolutionary developments in our concepts of space, time, matter, and energy, which also have been unfolding so rapidly during the first half of this extraordinary twentieth century in which we are now living.

The Framework of Creation

Until the close of the nineteenth century we thought we lived in a universe which in its fundamental structure was quite straightforward. Space had the three dimensions: length, breadth, and height, and space relations could be treated with simple Euclidean geometry where the three dimensions were at right angles to each other and everything was "on-the-square." Moreover, in this same forthright manner space seemed to extend out to infinity in all directions.

Time also was simple. It flowed on in a uniform way, as we thought it always must have done and always would do, pre-eternity to post-eternity, infinite, like space. And we accepted all this just as the natives in darkest Africa accept the river Zambesi where

> Nobody knows
> Whence it comes and whither it flows.

With the advent of the twentieth century it became increasingly clear that it was impossible to remain satisfied with this simple Newtonian time and space. There was the evidence for the constancy of the velocity of light, independent of the movement of the measuring instrument. This pointed toward a hitherto unsuspected relationship between space and time. There was the mass-defect in radioactive transformations of chemical elements. This pointed to a new relationship between mass and energy. Out of this kind of new experimental evidence we saw Einstein's theory of relativity emerge. Thus in many areas of our thinking we were forced to give up simple "four-square" space and time and to accept in its place a curved space-time manifold. It is analogous to the shift in our thinking when we had to give up the idea of a flat world and grudgingly accept the spherical planet as a consequence both of astronomical observations and circumnavigation. Just as we now know that the surface of the earth is not a flat plane extending out indefinitely in all directions, it appears that we also have to revise our ideas about a space extending indefinitely too. For just as the surface of our earth has a finite area, approximately 196,950,000 square miles; in the same way there is evidence that the amount of space in our universe *may* be finite, perhaps at present about 100,000,000,000

stroyed nor created; it obeyed a *conservation* law, exactly like the conservation law for matter.

Einstein first pointed out that these two conservation laws could not be regarded as true separately but were only valid when considered jointly within the larger framework of the theory of relativity which states that mass can be converted into energy. Perhaps never before has a theory ultimately been confirmed in such a big way; I refer, of course, to July 16, 1945, the first atomic explosion at Alamogordo, New Mexico in which the conversion of a few ounces of the mass of uranium produced the explosive force of twenty thousand tons of T.N.T.

The Nature of Matter

Now this concept of the interconversion of mass and energy is essential for interpreting our new evidence about creation. But I feel that an equally important consideration stems from the even more recent change in our thinking about energy and mass, the quantum or wave-mechanical approach to atoms which, figuratively speaking, implies that the tangible part of our universe is not *matter* but *music*. The first step toward this startling change in our thinking was, of course, the discovery that atoms are not in reality hard little balls but possess a structure like a planetary system, with a tiny nucleus in the center (the sun) and electrons moving in or out around it (the planets).

I think that even those of us who work with atoms have trouble in keeping clearly in mind the fantastically small magnitude of these atomic dimensions and the almost inconceivably large numbers of atoms in an ordinary object. For instance, take an atom of calcium in the bone of your finger; it is just one of the octillion atoms which make up your body, and an octillion is a really large number. For if all the oceans were frozen over and the entire surface of the earth were covered with peas to a height of a thousand feet, there would still be far fewer peas than the number of atoms in your body. You would have to collect a thousand planets each the size of the earth and cover each of them with peas a thousand feet deep, to amass the number of peas roughly equal to the number of atoms in your body. Thus this atom of calcium in the bone in your finger is quite small.

But now suppose you can eat an Alice-in-Wonderland growing pill and enlarge your body by a factor of a trillion so that you can lie across the earth's orbit around the sun with length to spare. Then this atom of calcium grows to a great sphere about a hundred yards across, big enough to put a football field inside. Suppose now that by some more magic you can stand inside this atom and look around. If you looked with the "eyes" of a scientist of the early 1920's, the "particle" point of view, you would "see" circling over your head, around at the sides, and under your feet some twenty spheres about the size of footballs. These would be of course the electrons, the negatively charged particles of electricity which by their motions

produce the forces which hold this atom of calcium bound to the neighboring atoms in your finger, making up the solid structure of bone. Their motions are much like the motions of planets circling around the sun. And if you looked down at the center of this great sphere, a hundred yards across, there you would see a tiny whirling speck, about the size of the head of a pin. That is the atomic nucleus, the "sun" which by its positive charge holds the planetary electrons in their orbits.

Thus we see how insubstantial matter is, a pin-head nuclus and a few foot-ball electrons in a spherical cavity that would hold a foot-ball field, only these few particles and everything else empty space. And since *we* are made of atoms we are nothing much but empty space too. If you were superman and you could squeeze my body in your hand, squeeze these atomic spaces out in the way you squeeze the holes out of a sponge, I would get smaller and smaller until finally when the last hole was gone, I would be about the size of the smallest speck of dust which you could see lying on this piece of paper. Thus the solid billiard ball picture of the atom of the nineteenth century was changed to the insubstantial planetary atom of the early twentieth century.

Now, although this was a very revolutionary change, its effect on scientific philosophy was not very great. The billiard ball concept of the atom had fitted nicely into the mechanistic picture of the universe, atoms being masses obeying the laws of mechanics. And when the atom turned into a planetary system the parts of this system still appeared to be obeying the laws of mechanics. The atom was thus a little machine, and since we were made of atoms, we humans seemed to be just bigger machines. The whole was simply equal to the sum of the parts.

Moreover in mechanics effect was believed to follow cause in an inexorable chain, and in our super-machine universe we seemed to see nothing but gears intermeshed, grinding inexorably on from pre-eternity to post-eternity. There was no room for soul or for significant destiny.

From Matter to Music

Then about 1925 came the truly startling change in the fundamental picture, a change initiated by De Broglie's suggestion of a *wave-aspect* of matter, complimentary to and in some ways even more significant than the *particle* picture just described — a change forced upon us by a host of confirmatory experimental evidence. Again, it is hard even for a physical scientist to grasp the full perspective of this change. But to get the broad outline, imagine that we can go back inside your calcium atom enlarged to the diameter of a football field; and we now wear more powerful "glasses" so that we "see" from the new *wave* point of view instead of from the earlier *particle* point of view. Now as we step inside the enlarged atom, the great sphere a hundred yards across, we "see" over our heads and under our feet a vast pattern of waves — waves suggestive of the ripples on a

pond when a stone is dropped in but unimaginably more complex. As we watch, from time to time we may see some waves pile up into something which looks like our previous football electron, but the essential picture is quite different. And if we not only "look" but "listen", if we have a super-magic hearing aid, we "hear" resounding about us a vast symphony of tones which in its harmony, counterpoint, and melodic structure carries us in complexity far beyond the bounds of any music ever heard or even dreamed of before. What this music "is" we do not know, but I believe one makes a true statement of fact to say that *it is there*, that this vast pattern of harmonic relations exists all round us and within us; since we are made of atoms, we are music and the whole universe is music. We do not hear it; it is not a kind which can be perceived by the human ear; it is a new kind of hyper-music in a new kind of hyper-space; but it is there.

At this point another word of caution is in order. Obviously one must not take my imaginative description of this trip inside the atom too literally. There is sharp disagreement today about what this wave-aspect of the atom means. As Margenau[2] has made so clear, before we can hope to define its meaning satisfactorily, both the experimental evidence on the one hand and our new theoretical concepts on the other have to be scrutinized much further with the most precise analysis which we can bring to bear. This must be done before we can project these ideas into the realms of philosophy, cosmology, or theology with any certainty. But I believe we do know enough to see what some of the possibilities are for discovering new points of view in these fields.

The Nature of Matter Waves

Some of the scientists most competent to assess this new pattern of hyper-harmony, Hermann Weyl[3] for example, believe that in this shift from *particle*-mathematics, to *wave*-mathematics, from matter to music, we have moved from a logical system where the whole was *equal* to the sum of the parts to a logical system where the whole is *more* than the sum of the parts. Put another way, as we have tried over the years to interpret the pattern of relationships observed in the universe, we have progressed first from simple Newtonian space-time to the more complicated curved space-time continuum of Einstein; today, in order to account for atomic behavior, it looks as if we are about to take another step forward into an even more startingly strange hyper-space-time in which *form* is the most significant reality. Unfortunately it is impossible to describe this hyper-space at all adequately without the use of mathematics; and even with mathematics it is difficult for the imagination to grasp the nature of such a concept. To try to

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[2] Henry Margenau, *The Nature of Physical Reality*. New York: McGraw-Hill, 1950.

[3] Hermann Weyl, *Philosophy, Mathematics and the Natural Sciences*. Princeton, N. J.: Princeton University Press, 1949, cf. esp. p. 262.

add just a single fourth dimension on to our familiar three stretches our conceptual powers; and to visualize a space of many extra dimensions is really impossible, I believe. But if one is willing to approach the problem as an exercise in analyzing the forms of relationships, there is a natural and logical way of generalizing from the relationships which lead us to believe in a space of three dimensions to relationships which suggest a hyper-space of *n*-dimensions, where *n* is as large as we like.

The transition from a space of three dimensions to a space of *n* dimensions alters the perspective and the emphasis on what is significant or what is real. With *n* dimensions there is less emphasis on the necessity for regarding any *particular set* of dimensions as *the ordained set,* the set which *really* exists. The forms or concepts contained in the dimensions take on a more persuasive reality. We seem to be moving[4]

In die schönen Regionen
Wo die reinen Formen wohnen.

Why do some of us believe in the possible reality of this new kind of space? Well, for the same kinds of reasons that made us believe in the reality of three-dimensional Newtonian space, namely the nature of the observed relationships. For example, if you have a dozen colored beads strung on a wire you can slide two beads to make them come closer together or to make them go further apart, but as long as the beads stay on the wire you cannot slide beads past one other or change the order of the sequence of the beads. These relationships create a *one*-dimensional *"space"* or *continuum;* relationship is measured in *length* only. Again, if you have a dozen pool balls on a table and the balls do not hop into the air, then their relationships to each other are expressed by specifying their positions with respect to the *length* and *breadth* of the table. These relationships create a space of *two* dimensions. Finally if you have a dozen flies in a bottle, they can move with respect to the *length, breadth and height* of the bottle; their relationships create a space of *three* dimensions.

Now the kinds of relationships which we humans *ordinarily* observe with our *common* senses point to the conclusion that we exist and move in a simple space of three dimensions. This seems to be true for the relationships of all objects of ordinary macroscopic size. But when we refine our senses with the help of laboratory instruments and study atoms and the component parts of atoms, then we find relationships which *so far* cannot be *expressed* in mathematical language involving only three simple dimensions. In a large number of our experiments the electron does *not* behave like an object which we can say is at a particular point in three-dimensional space. Moreover, when it hits another object, say a crystal

[4] Arthur O. Lovejoy, *The Revolt Against Dualism.* New York: Norton, 1930. p. 8.

face, it does not bounce off like a rubber ball from a wall. Instead the electron behaves as if it were spread out like a wave, as if it could be a large number of places at once; and when it hits the face of a crystal, it is reflected in a manner suggestive of a wave on the sea, reflected from the regularly spaced posts of a wharf.

Again, two electrons interacting with each other behave in a way completely different from the way in which two independent electrons act. In the collective pattern of action there are components of behavior which cannot be derived from the pattern of behavior of individual electrons acting independently. All these patterns of behavior are completely inexplicable if the electron is regarded as obeying the laws of classical mechanics in three-dimensional space. If, on the other hand, we postulate that the electron has a wave-like nature in complex hyper-space, then the pattern of mathematical relations associated with wave behavior are completely consistent with the reflection and interaction patterns of behavior of the electron just enumerated — patterns completely strange from the *particle* point of view.

Now the mathematical concepts suitable for correlation with this wave-behavior in hyper-space involve the so-called *imaginary* dimensions, associated with the square root of minus one. Why the name *imaginary* should be regarded as appropriate for this concept is hard for me to understand; I think it is probably because the concept is so difficult for the imagination to grasp! At any rate, possibly because some of the dimensions of these electron-waves are termed *imaginary*, there is considerable hesitancy among many scientists in accepting this new wave-space-time manifold as real or even accepting the waves as *real*, at least in the sense that most of us accept length, breadth, and height as real, and water waves as real.

Cosmology and the Nature of Space

Now it is just this sort of question regarding the nature of space, time, matter, and energy which it is important to keep in mind in interpreting the meaning of the new cosmology. For example, suppose we insist on taking classical Newtonian space-time as the basis of our thinking. It might be argued that an initial act of creation five billion years ago meant the sudden appearance of all matter and energy *ex nihilo* into a space and into a time *already there*. Certainly this leaves a good many loose ends of logic dangling. For example, how could there be time and space with nothing there?

Of course the interpretation of the red-shift in the light from the distant nebulae presupposes a somewhat more sophisticated time and space. An illustration frequently used is the analogy of the toy rubber balloon. Imagine that we have such a balloon about one foot in diameter and covered with polka-dots each

the size of a dime and spaced one inch apart. Now the balloon is inflated, and as it grows larger in size the dots move further and further apart. If an ant were clinging to the balloon at the middle of one of the polka-dots, all the other dots which it saw would appear to be rushing away from it as the balloon expanded. If the ant's line of sight followed the surface of the balloon the farthest dots would appear to rush away fastest.

By analogy we can interpret the motions of the nebulae around us in space in a somewhat similar manner. We observe that the farther away the nebulae are, the faster they seem to be rushing away from us. Are the nebulae then "polka dots" on a four-dimensional balloon? Astronomical evidence interpreted by the theory of relativity suggests that space may be curved; and just as the surface of the toy balloon is a two-dimensional curved space existing in our familiar three dimensions of length, breadth, and height, this three dimensional space in which we seem to live may be a three-dimensional curved hyper-surface of a hyper-space-balloon expanding in a realm of four dimensions, namely length, breadth, height, and dimension-x. So perhaps the nebulae are moving further apart like the polka-dots on the balloon, rather large polka-dots to be sure, very roughly some quintillion miles across. Knowing how fast this space balloon is expanding and assuming a *constant* rate of expansion, we calculate back that the expansion started five billion years ago!

At this point we have to examine our logic carefully for doubtful links. How logical is it to assume a constant rate of expansion of the universe during the first few years, the first few days, or the first few seconds after creation? Can our measure of time be extended back to an initial point? For example the concept of the expanding universe really rests on the framework of the theory of relativity; in many ways relativity implies that space and time are *created* by matter and energy; thus, as we move backward in history and approach the *time* of creation, it would seem very doubtful to assume that we still deal with a constant expansion rate. J. T. Davies[5] has recently called attention to the dangers inherent in this kind of linear extrapolation.

I believe that all this points again to the peculiar difficulties encountered in this problem of creation, due to the fact that it is a *boundary* problem. For we must expect to find familiar ideas no longer applicable at basic boundaries. Take the boundary as we approach the realm of the very small. If we extrapolate linearly, we expect matter to have the property of divisibility into smaller and smaller bits *ad infinitum;* and we expect to find the laws of classical mechanics applicable, no matter how small the particles are. Actually we find that classical laws break down and new qualitative relationships appear. Thus matter is not infinitely divisible;

[5] J. T. Davis, "On Extrapolation, with Special Reference to the 'Age of the Universe'," *The British Journal for the Philosophy of Science*, Vol. 7 (1956), p. 129.

we find the quantum phenomena and our basic ideas of space and time have to be revised, as is shown by the need for wave-mechanics at the boundary of the very small.

Or take the boundary of the very large. Instead of space extending monotonously out for ever with a uniform universe filling it to infinity, we find the red-shift, apparent curvature of space, and again new qualitative relationships.

It is not unreasonable to suppose, therefore, that we will find new qualitative relationships holding as we go backward toward the initial boundary of time. It is in this frame of mind that I believe we should approach the problem of creation. It is for this reason that I think there is so much significance in the bearing on this problem of the aspects of atomic quantum mechanics which suggests that for understanding the nature of and the interactions of fundamental particles we have to accept an even greater complexity in the nature of space and time — a complexity greater even that that which is inherent in the theory of relativity.

Matter Waves and Hyper-space

In conclusion I want to outline briefly one new approach to the problem of creation which the nature of wave-mechanics suggests. Wave-mechanics, or more broadly speaking, quantum-mechanics, is a ***language*** for talking about relationships which are found in our study of fundamental particles. In order to express these relationships precisely this language has to be mathematical. But because of the variety and flexibility of various mathematical languages available, there is a choice of language types. We can use the language of Schroedinger which emphasizes the resemblance of these electron "waves" to light waves or sound waves or even the waves which we can see with the naked eye on water. Or we can use the matrix-mechanics of Heisenberg which emphasizes the fact that the harmonic relations, frequently observed when waves are studied (either sound, light, or particle waves), are more fundamentally understood in terms of form; the mathematics here stresses the concept of invariant form expressible in a variety of multi-dimensional hyper-spaces; the quality of form is seen frequently to be associated with whole-number relationships and with the so-called "group" relationships, which can be represented by permutations and which express varieties of symmetry. In some ways the choice either of wave-mechanics or of matrix-mechanics as the "language" in which to state an atomic relationship is much like the choice of English or German as the language for describing, say, the behavior of a baby. Neither the oral language nor the mathematical language ever attains anything like the complete adequacy; but the language can convey aspects of relationship and form which transcend both the choice of the language and the inadequacy of the language chosen. And because these aspects are essentially invariant or independent of the language used to describe them, they may be called true and real.

Now in the world of atoms we find such relationships of form which are both harmonic and dynamic. To get the "feel" of these relationships it is certainly suggestive to regard them as *music*, though one has to specify carefully the implied extension of the idea of familiar music to the kind of hyper-music necessary to describe the atom. Thus the music which we hear in the concert hall may be regarded as relatively simple, for the harmonic intervals, the whole-number ratios employed even by the most avant-garde composers, are at kindergarten level compared with the "harmony" implied in even the combinations of a few atoms. Though in another sense, taking into account the timbre of the tones of the various instruments of a modern symphony orchestra, I suppose it is doubtful whether we are even beginning to understand the subtleties of form in a symphony superbly performed. At any rate, considering all the ranges of human perception and creativity, music probably comes nearest in its nature to the ensemble of relationships observed in the atomic world. It is true that expressed in matrix-language instead of wave-language the analogy is less obvious; the variables involved in the atomic problem seem at first glance more numerous and related differently dimensionally than the variables in music; but at the present level of our understanding I believe we are justified in using the community of form which we do perceive between music and atomic relationships as a guide in our thinking. And I believe that as our knowledge in each of these fields extends the significance of their common pattern will wax rather than wane, for in both we deal with harmonic relations, which are dynamic, involving space as well as time and energy.

Now the matrix language to me emphasizes the special significance, or reality if you will, of certain relationships which transcend transformation. These are the relationships of wholes. An analogy in music is the transposing of the major-triad chord from one key to another; the chord is instantly recognizable irrespective of the key in which it happens to be played. In fact most of us can recognize at once that it is the major triad but cannot say what key it is being played in. By way of contrast with the simultaneous notes of the triad, three separate notes struck in sequence with a long interval between each note have no pattern of the whole which gives us a clue to any characteristic identity. If each of these three notes were struck five minutes apart, I am sure I could not tell whether they they were related as a major triad, say C E G, or whether they were three sequential notes in a scale, say C D E. There is a quality of the whole in the three notes struck simultaneously which is not present in the three notes struck separately. The whole is more than the sum of the parts. The illustration of this principle in music is only suggestive; in quantum-mechanics it is precisely and quantitatively apparent.

Now we ask the question: "To what shall we apply the title of reality — particle or wave, part or whole?" At this point this principle of the relation between

parts and wholes becomes very important. In music it may not mean very much to say that the chord is more "real" than the individual notes. In the atom it does have a good deal of meaning to say that the relationship of the whole "exists" in a more positive sense than the existence of an individual electron. For we are compelled to say by the Heisenberg indeterminacy principle that usually we do not know precisely where the electron is, that it is smeared out over a relatively large area.

Thus, I think, there is a good deal of agreement that the electron as normally attached to the atom has become quite shadowy and evanescent. A hundred years ago it might have been said that the parts, the fundamental particles, were the tangible realities and that the aspect of the whole was only the shadow cast by the parts. Today, it seems equally logical to say that the wholes are the tangible reality and that the parts are only evanescent shadows cast by certain aspects of the wholes. In fact some physicists have gone so far as to say that electrons and even atoms only exist when we tear apart wholes under the very special conditions present in laboratory instruments.

This point of view can be extended in a way which cannot be called scientific proof but which does merit some thoughtful consideration. In living matter the whole cell maintains with astonishing fidelity its identity, its distinguishing characteristics, throughout vast series of transformations. Atoms come and go in the process of metabolism; fission and reproduction occur but identity is maintained essentially invariant throughout untold millions of transformations. Thus it reminds us of the invariance of the identity of the major triad chord throughout numberless transpositions from key to key.

Again, regard your own body. In the course of each breath you inhale trillions of atoms of oxygen which enter and replace other trillions which are expelled as carbon dioxide; in fact your whole metabolic proccess is one of transformation. There is evidence that you get essentially a whole new set of octillion atoms, a whole new body atomically speaking, every five years or less. Yet life goes on and you remain essentially the same person anatomically. Thus, if we can accept the principle that the test of reality is invariance under transformation, here is evidence to suggest the presence within you of a reality far deeper than has appeared even in the wholes of atoms. No matter how we wish to designate the dynamic center which dominates and controls the unimaginably vast transformations of human metabolism and function — whether we call it vital-spark or spirit or soul — its relation to the principle of invariance under transformation certainly raises the question whether it does not have a high claim to one of the most profound kinds of reality in our new cosmology.

At this point we should also discuss briefly the problem of determinism. Whereas the classical mechanics implied the inexorable chain, a philosophy of

determinism, the quantum-mechanics rests on the principle that there is no completely predictable relationship between cause and effect at the atomic level. In other words atomic science no longer categorically *denies* free-will in the way classical mechanics did. It is still too early to say what atomic science *affirms* in this regard; but it again focuses our attention on the *whole* aspects of molecular organization in seeking to find meaning in the sequence of life; and there is every reason to believe that an ability to view the problem of cosmology in terms of a *form* hyper-space will help us to understand better its broadest aspects of meaning and destiny.

Conclusions

Summing up this necessarily hasty survey of the questions which this new evidence on "creation" has raised, I feel first of all that we are forced to regard "creation" as a *boundary problem,* the problem of the initial boundary of time, space, matter, and energy. In going back toward this boundary we cannot expect to be able to extrapolate linearly back to an initial point; we cannot say that the figure "five billion years" really tells the whole story as far as *time* is concerned. It is significant of course that both the evidence from the very small and from the very large add up to five billion years; for this is a kind of mathematical limit on the ordinary meaning of time. But the full meaning of time as we go back toward the initial point must be involved with the deeper relationships of time with space, matter, and energy. The pattern of these relationships is almost sure to be of a different nature, just as the pattern of relationships between these quantities changes as we approach the boundary of the very small in the atom or the boundary of the very large in the farthest nebulae.

In trying to get a glimpse of what this changing nature of relationships may be as we approach the initial boundary of time, I believe we have to project our thinking into the new quantum-mechanical manifold of relationships rather than merely into relativistic space-time. Along this line it is true one might argue that, according to the evidence we have just reviewed, a trip far enough backward in time would bring us to a state where all matter and energy would be gathered together essentially at a point; and under those conditions all matter and energy would be present as light. Since this would be the initial point in time, it suggests that the biblical description of creation was an almost perfect summary; "God said 'Let there be light', and there was light." But this view taken alone hardly seems to open the door toward any deeper understanding of the questions of the meaning of *ex nihilo,* pre-eternity, and purpose.

Professor Paul L. Lehmann has suggested to me that if we might regard the use of the image of light by the writer of the book of Genesis as a profound hint of what was involved at the temporal beginning of creation, so we might regard as similarly profound their use of the image of the deep, that vast deep of

waves, that deepest wave aspect of the universe which we now first begin to perceive through our penetration of the inner atom. "Darkness was upon the face of the deep. And the Spirit of God moved upon the face of the waters." Here perhaps we begin to see back into pre-eternity. Consider that in the aspect of the whole human being we recognize a dominant reality which transcends the common transformations of space and time — the human spirit. In the aspect of the whole universe similarly perhaps we can get a glimpse of the ultimate reality, the Spirit of its Creator.

So it is of the greatest interest that evidence from science should point towards an initial event. And viewed in terms of the hyper-space of form, the meaning of this event is not a creation *ex nihilo* into an unaccounted-for pre-existing space and time. Rather the meaning of creation, seen in terms of our new framework of atomic hyper-music, may be an emergence of the perceivable, of matter and movement, of space and time out of the total reality of Spirit which is both the unknowable and the fount of all knowing.

Ortega y Gasset has said that simple time and space are the stupid aspects of the universe.[6] Modern atomic science points to the plenum that lies beyond the vacuity of simple space and time.

The point is frequently made that faith is endangered when it is enmeshed with fact which may be true today and false tomorrow. Certainly no scientist will ever claim completeness of truth for scientific fact; it is always an incomplete and distorted vision which reveals only the dimmest outline of the veiled reality. Yet in its incompleteness and distortion science is still one of the few helpful guides in our eternal groping for truth. And accepted for what it is, science can become a help and not a hindrance to faith, as it unfortunately appears to have been to so many for so long.

Moreover in this mid-twentieth century science has rightly or wrongly attained enormous prestige. I think it is no exaggeration that in many areas science is threatening to supplant religion as a guide to life. Certainly if there were ever a time when we needed the most effective spiritual guidance, it is right now in this age when physical power stemming from science has grown so great as to threaten all life on earth.

It is for this reason that I think there is an imperative call for theologians, philosophers, and scientists to help each other to attain a deeper understanding of these problems where all three disciplines meet on common ground. A clearer view of beginnings is almost certain to mean a clearer view of ends. Perhaps a clearer understanding of creation will give us a clearer understanding of destiny. This kind of wisdom is needed today.

[6] José Ortega y Gassett, *The Revolt of the Masses*. New York: Norton and Co., 1932, p. 42.

Man's Idea of Nature

MICHAEL B. FOSTER

The ancient Greeks originated the idea of nature. They meant by the "nature" of anything something in the thing which makes it behave the way it does; just as the nature of a man is something in him which makes him behave the way he does.

If a man is rational, then a knowledge of his nature will enable us to understand the way he acts, but we shan't see any sense in what he does if he is not rational. The Greeks thought things were on the whole rational, not of course in the sense that they possessed understanding, but that a knowledge of their natures would enable you to understand the way they behave. This understanding is science, and therefore the Greeks held that a science of nature is possible.

They thought, too, that natural things are not isolated from one another, but that they are related together in one single system, or world; and they used the word "nature" also to describe this world or totality of natural things.

Our conception of nature has been derived from the Greeks. By "our conception" I mean the conception of nature which has been common to men educated in Western traditions since the seventeenth century. It has been superseded in some important respects by recent developments in physics associated with the name of Einstein, but it still governs the habitual modes of looking at the world of those of us who are not professional physicists. For other than European peoples an important element in the process which we call "becoming Westernized" consists in the fact that they adopt this view of nature. The description which would give the right picture of it to most people would be to call it "the scientific" view of nature; but I think it will be best if I just call it the "modern view." (When it is necessary to distinguish it from the *most* modern physics, it can be specified as the "classical modern" view.)

This view of nature has some elements in common with the Greek; but it has some important differences, and the Greek view would certainly appear "unscientific" to a modern mind.

The first great difference is that the Greeks thought that natural things were alive. Or rather, that's a misleading way of stating it, because it supposes a clear distinction which the Greeks did not make. They did not distinguish, as we do, between the inorganic and the organic, and then say: "In spite of appearances, inorganic things like stones and metals are really just as much alive as plants and animals." But they failed to make the fundamental distinction between the organic

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and the inorganic. They thought that inorganic things were made to act in certain ways by the possession of "natures." These natures were not, it is true, quite the same as the life which animates a plant or animal, but they were lower grades of the same kind of thing. The nature of a stone, which impels it towards the earth so that it falls when unsupported, or of fire, which makes it ascend upwards, are thought of, one might almost say, as low-grade instincts. They are lower forms of the same kind of urge which impels a plant towards the light or a homing-pigeon towards its loft.

When the Greeks spoke of natural things they had in mind the contrast with artificial things. Artificial things lacked this internal source of movement. They were inert, as a statue is inert compared with a living man. They therefore could be moved only by force imparted from without. But natural things (inorganic as well as organic) were distinguished from artificial by possessing an internal source of movement.

By contrast with this the modern view of nature distinguished sharply between living and inorganic matter and held all inorganic objects to be inert in the same sense in which the Greeks had held all artificial objects to be so. It followed that all movement in the material world (except in the small region of the organic) had to be conceived as imparted to inert bodies from without. This conception was the basis of the modern laws of motion and the modern science of mechanics. Consequently the Greeks thought of nature as a whole as a gigantic living organism; the moderns as a gigantic machine.

This distinction, together with much else that I have said, is expounded in his brilliant book, *The Idea of Nature,* by the late Professor Collingwood and also in Bertrand Russell's *History of Western Philosophy.*

There is a second difference between the Greek and the modern views of nature. In describing it, I shall have to exaggerate, because on many points some Greeks outstripped the Greek view and partly anticipated the modern. I shall have to ignore these anticipations.

The Greeks thought that nature includes everything there is. It included all beings, material and immaterial, inorganic and living, earthly and heavenly, human and divine. But the classical modern view, at least in the form in which it was expounded by the great philosophers and assumed by the great scientists of the seventeenth century, held that nature was not all that there is. Mind and God were not parts of nature but were something else than nature.

I will expand one of these points of difference. The Greek conception of nature was one which could include divine beings. It was not repugnant to it to include God or gods in nature. Aristotle for example thought that the heavenly bodies were divine. They were guided in their movements by immortal intelli-

gences. They were made of a different element from those which composed terrestrial bodies. They were capable of a different and more perfect kind of motion; for whereas terrestrial bodies moved naturally in a straight line (whether upwards, like fire, or downwards, like earth), the heavenly bodies moved naturally in a circle. Hence there were two branches of physics, terrestrial and celestial, one of which studied the laws of heavenly, the other those of earthly motion.

The classical modern view of nature held that, while nature is made by God, no part of nature is divine. There is therefore not a celestial and a terrestrial physics but one physics for both celestial and terrestrial objects. The heavenly bodies are made of the same kind of matter as earthly bodies are, and Newton in his theory of gravitation showed that their circular motion is governed by the same laws as the linear motion of bodies on earth. The founders of the classical modern view were convinced that there existed, besides nature, God who made it and mind which knows it. You may object that, whatever may have been true in the seventeenth century, more recent scientists have not necessarily believed either in God or in mind, and this has not prevented them from being good scientists. Indeed the common scientific point of view is one which concentrates attention upon nature and either denies or suspends judgment about everything else. This is quite true. The only thing I wish to point out is that the view of nature with which science works is one which was formed by excluding God and mind, and that this makes it different from the Greek view of a nature including divine and mental being. This Greek view would seem to us highly unscientific if we came across it.

What are we to say of the *truth* of this "classical modern" view of nature? In some respects it has been superseded, in the minds of scientists, if not in the general consciousness, by the most recent developments of physics. Are we to say, in the spirit of historical relativism, that it was called forth by the historical circumstances of the age which produced it, just as the Greek view of nature was called forth by the historical conditions of ancient Greece, and as the conditions of the present age are in their turn producing their own appropriate theory? I don't think we should adopt this purely negative attitude. I think we are bound to say that the "classical modern" view of nature, although it has been found not to be wholly true, at least has more truth than the Greek view. The Greeks, with all the brilliant successes that they had in mathematics and philosophy, failed in natural science. But the classical modern natural science, though its assumptions may be liable to criticism and though it is in some respects out of date now, succeeded. Even if we cut short its record in the year 1850, that is to say before the most recent developments had begun, we should still have to say that the body of natural science developed up to that date was one of the greatest intellectual achievements in human history.

Where did this view of nature come from — this view which established itself in Western Europe in the seventeenth century and has since proved itself capable in every quarter of the globe of expelling all rival views from the minds of men?

Many may think this a needless question. The source of this view of nature they will say is obvious. Men observed nature and found that it was like that. And if you ask why in that case this view did not develop until the seventeenth century A.D., they would probably explain it by saying that it was not until the seventeenth century that men started observing nature with unprejudiced minds. This is undoubtedly the answer which the men of the seventeenth century themselves would have made. It is the answer which Bertrand Russell makes in the book which I have cited.

He says, "The result of the scientific work we have been considering was that the outlook of educated men was completely transformed. At the beginning of the century (i.e. the seventeenth century) Sir Thomas Browne took part in trials for witchcraft; at the end, such a thing would have been impossible."

"*The result* of the scientific work . . . was that the outlook of educated men was completely transformed." That seems to me half the truth, but only half. The other half is that unless their outlook had been first transformed, they would never have approached nature in the way they did and would never therefore have accomplished that scientific work."

What was it that changed their outlook? They themselves used to refer to the anticipations of the new outlook which they discovered among the Greek writers. Their attitude to the teaching of the centuries which immediately preceded their time — the centuries of the early Christian church and the Christian Middle Ages — was one of reaction and rejection so far as this teaching concerned science or philosophy. In science and philosophy what had gone before was to their minds superstition and prejudice; what they had to do was to free their minds from it and to start afresh on a basis of unbiased observation. We still very largely share the same attitude. Bertrand Russell is an uncompromising exponent of it. But I want to suggest to you that it is mistaken. The truth is that the principal influence which changed men's minds in the interval between the ancient and the modern worlds and produced the new outlook from which in the seventeenth century modern science grew up was the teaching of the Christian religion.

Let us consider some examples. The Christian doctrine about nature is that it is created by God. All the philosophers and scientists of the early modern period knew in their bones, as the result of sixteen centuries of Christian teaching, that nature was something which had been made. Their minds were therefore open, as those of the Greeks could not have been, to the idea that nature was a machine and not an organism.

All the early scientists knew similarly before they even started looking through their telescopes that God had created the firmament in the same way as He had created the earth. Therefore one part of nature could not be divine in a way in which another was not, and there could not therefore be two kinds of

physics, celestial and terrestrial, but the bodies in the heavens must obey the same laws as those on earth. Newton was given a very good start towards his theory by the first chapter of Genesis.

God was omnipotent. This is a Christian idea, not a Greek one. Therefore the laws which govern the behavior of things in nature must be such as do not admit of exceptions. This was one of the fundamental principles of the modern science of nature.

God, according to the Christian doctrine, made the world by a fiat of his will which is inscrutable. No man can have such a knowledge of God's nature that he can say beforehand how God is bound to act. God is to be known only through his works.

This is the origin of that humility before the given fact which is characteristic of the modern scientific spirit and differentiates it from the *a priori* speculation of the Greeks. The Greeks thought they could decide what nature must be like by logical and dialectical argument round a table (for example, the heavenly bodies must travel in circular orbits because the circle is the perfect figure). But the moderns know that there is in this sense no "must" about nature and that the only way to find out is to go and see and to abide by what you find.

I know that objections to what I have said will readily occur. We have all been told that the Church persecuted Galileo; that many of the pioneers of the modern scientific spirit had to work against ecclesiastical opposition; and that there has been a conflict between religion and science ever since. This is true on the whole. There are many things which ought to be said about it. I will mention only one. In some of the things in which the churchmen opposed the scientists, they were not defending essential Christian doctrines; they were clinging to fragments of Greek doctrine which had been taken over and become embedded in the doctrine of the Church.

If the modern scientific world view was derived from Christianity, why did it not appear sooner? Why did it take sixteen centuries to alter men's view of nature? The answer is, I think, that it is one thing to adopt a faith but quite a different thing to let that faith permeate all departments of thought and action. The process of permeation is slow, difficult, and imperfect. The Christian doctrine of the brotherhood of all men, for example, was accepted for over seventeen centuries before it permeated the sphere of social practice sufficiently to bring about the abolition of slavery in the Western world. It took the Christian doctrine of creation a slightly shorter time to permeate men's views of nature sufficiently to form the basis of modern natural science.

Let us return to Bertrand Russell's description of the change in men's outlook which took place in the seventeenth century. By the end of the century, he

says "the reign of law had established its hold on men's imaginations, making such things as magic and sorcery incredible. In 1700 the mental outlook of educated men was completely modern; in 1600, except among a very few, it was still largely mediaeval." The change which Russell thus describes liberated men from a certain kind of fear. from the fear namely of capricious, incalculable, uncontrolled powers in nature. Henceforth men knew that, although much in nature remained unknown, there were no forces in nature let loose from control.

The Christian doctrine of God brought a similar liberation to pagans enslaved to superstitious fears. It gave them the faith that there were no independent powers in the world, whether hostile or capricious, but that all were controlled, even the devil himself, by the hand of an all-powerful God. This is the teaching of the Book of Job and of St. Augustine against the upholders of the pagan religions. This is the faith which transformed men's view of nature when it was carried over from religion to science in the seventeenth century.

Fideistic and Scientific Methods

Mary Carman Rose

It is the aim of this paper to show how faith which, in accordance with the contemporary idiom, might be called the "method of religion," differs from the method of science.

Christians of all generations share the same faith which is the source of their conviction that there is a God and that the beliefs of Trinitarian Christianity are true. The whole-hearted believer who lives in the twentieth century finds the essential nature of his own faith in the experience of Paul, John, Augustine, or Kierkegaard. Of course, these Christians are different from each other, and in some ways each is different from every contemporary believer. It is essential to the nature of faith, however, that while in all its occurrences it remains fundamentally the same, its universal characteristics are always present in a manner required by the intellectual and temperamental nature of the individual who possesses the faith.

It is also true that each philosophical generation must explicate the nature of faith against the background of its own dominant epistemological orientation toward the study of the physical world. The two great epistemological tasks of philosophy have been the discovery of the proper approach to the knowledge of nature, on the one hand, and to the knowledge of God and of the things of God, on the other. Augustine explains the nature of his faith using the concepts and the intellectual structure provided by Platonism; and *mutatis mutandis* the same can be said for Thomas Aquinas and his use of Aristotelian rationalism.[1] In our day both the Platonic and the Aristotelian forms of rationalism are largely discredited as the proper methodological approaches to nature; contemporary scientific empiricism proceeds without benefit of innate ideas or of "intuitive induction." One task for the present-day writer in the field of philosophy of religion, then, is the development of the differences as well as the similarities between faith and the scientific empiricism which we have discovered to be the most successful approach to the study of nature.

To understand the method of science and what might be called the "epistemology of religion" is to see that there is no conflict between them. These are distinct methods, having separate goals and involving different activities. Science

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[1] It is my opinion that Augustine's Platonic arguments for the existence of God are of less importance than the histories of philosophies have made them. These and other Platonic elements of Augustine's work have a secondary importance for Augustine himself; they serve primarily to give additional clarity to what Augustine believes on other grounds. I would make a similar analysis of the rationalism of Thomas Aquinas. Thus for my point of view Neo-Thomism represents a misunderstanding of the thirteenth century epistemological task of Thomas himself.

is the disinterested pursuit of facts about nature. It makes no demands on the valuational capacities of the investigator except that it expects him to be intellectually honest and to possess a love of truth. Contemporary naturalism commits a grave philosophical error, however, in assuming that this disinterested approach is the necessary and sufficient attitude for the discovery of all those truths which men need for the conduct of their lives. Insight concerning God is a gift of grace to those who are not disinterested in their attitude toward the possible existence of God, but who are attracted by the moral development which is a potentiality for them if Christianity is true. The grace of religious insight is given to those who — in terms of their own present moral insight[2] — possess moral earnestness. One important epistemological task for the twentieth century is the clarification of the significance of the differences between the disinterested attitude of science and the "existential concern of faith." In what follows I shall attempt to provide such a clarification.

Science is most fundamentally a development of empiricism in the study of what is either directly or indirectly symbolized in our experience. Scientific empiricism has been most successful in the study of what can be known through the sense data which pertain to the non-human aspects of nature and which can receive a quantitative expression. There is today no universal agreement concerning either the possibility of a science of specifically human activity or the scientific usefulness of subjective or private data. These, however, are not questions which are relevant for this discussion. It is not any one of the sciences that must be distinguished from religion, but rather the generic method of empiricism of which all the methods of science represent specialized developments. Empiricism seeks to answer questions which pertain to nature and answers them by finding a hypothesis which will be conformed to the available experiental data. Except in very simple investigations which require only a generalization about the observations, this hypothesis must be the product of speculative imagination and perhaps of a fortunate "hunch" and must go beyond the categories and the data of the immediately given. Further, empiricism is most significantly distinguished from Platonic and Aristotelian rationalism by its requirement that what the hypothetical answer predicts must be compared to what experience provides — this requirement constituting empiricism's most significant criterion of truth.[3]

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[2] This moral insight will be initially incomplete and usually also contain errors. The religious life, so far from being static, brings growing insight into the nature of the necessarily non-relativistic Christian ideal.

[3] I have described empiricism in terms of metaphysical realism, but this metaphysical realism is present as a neutral hypothesis. Though the epistemological idealism of Kant, positivism, and some forms of pragmatism differ from metaphysical realism — and also among themselves — in their view concerning the nature of the entities which are the objects of scientific investigation, there is no disagreement among the proponents of these views concerning the essential nature of the empirical method.

In what follows I shall try to show that there are six significant differences between empiricism and faith.

1. Empiricism involves a relation between the investigator and an entity which — as object of investigation — remains passive. The object is in some way present to the investigator, and if he possesses the requisite training, objectivity, and scientific talent, he may succeed in coming to know "how things really are"; but the object of scientific investigation does not actively become the teacher of the scientist. On the other hand, the epistemology of faith turns upon the importance of the role of God who in relation to the believer has become a teacher.[4] God as teacher provides the individual with those occasions of contentment, of joy, and of suffering which the individual can, if he will, so appropriate with moral earnestness that his attitude in these experiences constitutes what for him is the condition of his receiving both the grace of enlightenment concerning the things of God and increased moral capacities.

When the possible existence of God becomes the object of an empirical investigation (e.g., an investigation of historical documents or of the "psychology of religion"), the result is the discipline of comparative religion or an array of facts pertaining to the "variety of religious experience," but never religiously significant insight into the nature of God.

2. The epistemology of religion involves the insufficiency — though not irrelevance — of the activities, the intellectual cultivation, and the talent which are all-important in scientific investigation. It is not the case that these are wholly irrelevant to faith since the strictures against conscious or unconscious dishonesty and against lack of clarity are as important in religion as they are in science. Further, the degree of the believer's reflectiveness and intellectual cultivation will determine to what extent he will seek philosophical understanding of what, since it must be fundamentally an implicit and pervasive way of life, can never be initially grasped as an abstraction or as an intellectual system. In religion it is the individual's experience of the disvaluable and the valuable — evil and good; the indifferent, the tragic, and the joyous; distraction and peace — which must contribute data for reflection. Before the individual can comprehend the religious he must find in his experience the data which will enable him through reflection to recognize the religious as the most adequate interpretation of human nature and of human affairs. There will be no such data for his reflection if he has not discovered the discontinuity between secular goods and his potentialities for moral development; if he has not been severely disciplined by the inadequacy of the secular; or, if having discovered the despair that is possible when the wholly

[4] Of course this is true in a two-fold sense. Jesus' ministry on earth was the work of a teacher. What I mean here however is God's essential and permanent relation to every human being.

natural is made the only source of his peace, he has not chosen — as over against the despair — to explore the possibility that peace may be found in an other-than-natural object for which devotion to the moral is the only significant instrument of discovery. The individual's intellectual capacities and their cultivation will determine, in part, how the religious will be present in his nature; but the initial discovery of the potential importance and of the nature of the religious is not essentially the work of the intellect but of the moral nature. Thus, faith as a "method" makes a distinction between the function of the intellect and the function of the experience in relation to values. Here the moral nature has a function which the intellect cannot perform, though this does not mean that the intellect has no function nor that an interest in the claims of the moral nature involves a denial of the claims of the intellect.

3. The individual must come to reflect upon the data supplied by his moral nature in a manner which is irrelevant in science. The disinterested attitude of empiricism must be replaced by the religiously significant mode of reflection in which the individual is genuinely concerned with what he becomes in relation to the ideal he has glimpsed and with the import of religion for this ideal. The claims of religion — that there is a God whose goodness is at once the ground of man's moral ideal and also the earnest of God's concern for the individual — have the highest importance for the potentialities of the individual's moral nature. The beginning of the truly religious attitude is the cultivation of an interest in the significance of religion for one's own capacities to appreciate and to appropriate the content of the moral ideal.

4. Empiricism attempts no task that is permanently beyond the scope of natural human faculties. Empiricism, that is, does not imply the need for the enlightenment of grace. On the other hand, the epistemology of Christianity implies that the natural faculties by themselves can only conclude either that Christianity is an absurdity or that it is at best an interesting intellectual possibility. Christian faith must remain at its heart a passionate pursuit of a moral possibility, while grace provides increasing insight concerning the moral and increasing capacities to appropriate the moral. Also, as a supplement to this most essential aspect of faith which, as I have just said, is the passionate concern to possess the moral ideal of Christianity and to know the infinitely good God if he exists, grace can provide intellectual enlightenment concerning the things of God, and also experience which serves as evidence that the claims of Christianity are true.[5] Within

[5] By "intellectual enlightenment" I mean the presence of a pervasive explanation (analogous to a hypothesis). By "evidence" I mean experience which serves to verify some aspect of the complex belief of Christianity. For example John's "my spirit left my body" obviously provided him with evidence that the belief in immortality was justified and with a partial explanation of how immortality is possible. Paul's experience on the road to Damascus likewise constituted evidence for Paul; he received no intellectual insight concerning how the Incarnation was possible; he met the Incarnation. Obviously all mystic experience provides explanation or

the epistemology of faith, the only reflection about religion that can do its work properly is that in which the intellect and the moral nature are enlightened by grace.

5. While the criteria of truth within empiricism are easily distinguished, the clarification of the mode of justification of religious truths is a task as difficult as it is philosophically important. The task is difficult for two reasons. First, the analysis which determines which criteria are present in religious belief must abstract these criteria from the most concrete, pervasive, and individualized experience. Second, on another level of analysis, the judging of the validity of these criteria is not only an intellectual one, but it is a task in which the activity of the intellect must be supplemented by the understanding provided by the valuational nature of the analyst himself.

For the believer there are at least two important criteria present in the acceptance of the Christian philosophy as true. First, there are the data some of which William James took to be a verification of a portion — but only a portion — of what I mean by the "religious."[6] At the very least, that is, there is the Christian's discovery that the whole-hearted living in religious categories brings a release of tension, criteria for the resolution of conflicts in values, and a conviction of the profound meaningfulness and importance of life. The listing of these effects of belief, however, has become a commonplace. The essential valuational effect of belief is the discovery that the willingness to act now in terms of the values of Christianity and to appropriate all the experiences of this life for the sake of the "eternal weight of glory" brings, if I may coin a word, the "eternalization" of this life — brings, that is, the peace which the wholly secular can neither possess nor understand.

Second, when the individual lives his life in religious categories, grace provides experiential data for reflection, data which cannot be present in the life of the person whose orientation is wholly naturalistic or who does not bring a primarily moral interest. These data most essentially pertain to the true understanding of the significance and the depth of religious values. What other religiously significant data are present will depend upon the religious temperament and the needs of the individual. These experiences together make possible a speculative

evidence or both. That most Christian lives do not include these experiences does not mean that these experiences do not occur but rather that moral aspiration constitutes the essence of faith. In this life every human being has the "religious experience" which he needs either for his own religious development or for the work he is to do here for others.

[6] The assumption in this paper is that among religious views Christianity represents a maximum of religious insight. William James' great *Varieties of Religious Experience* is the work of a person who saw, or who chose to express in his work, only the existence of a universe more spiritual than the visible world. Christianity with its belief in the Holy Ghost, immortality, and the Incarnation is a far more specific and complex set of beliefs than James' hypothesis.

interpretation of human nature and of human affairs which possesses an adequacy and coherence superior to that of naturalism and of all non-religious views.

These criteria are epistemologically valid. The believer's intellectually honest judgement is that the experiences of his religious life point to the conclusion that the religious is probably true. The epistemology of religion, like empiricism, involves clear, uncompromising reflection on experience, but it must be remembered that the value experiences which for all men are the most important ground of religious belief are not present unless the individual approaches Christianity with an interest in its moral potentialities for him.

6. The goal of empiricism is the discovery of facts about the space-time world of nature. Religion, however, answers to an aspect of the self which is more fundamental and pervasive than that which empiricism serves. Every human interest — including the interest in the pursuit of truth — is an expression of man's nature as a valuer, and religion claims to be conformed to the most fundamental and pervasive aspect of the valuational nature of the individual. The fact that the individual is a valuer means, in part, that he hopes for the continued possession of certain goods, the particular goods he chooses depending upon which aspects of his nature are developed and which remain latent. There are other modes in which values may be present in the life of the individual, but all those values which the individual wants to possess continually might be called the "fundamental values." Every non-relativistic interpretation of life is a prescription of fundamental values, and it is the conviction of Christianity that its values — the choosing of which constitutes a life lived in religious categories — are the values which answer to the ideal potentialities of the human valuational nature.

Once the differences between science and religion are understood, the resemblances between them can be seen in their proper perspective. Science and religion both have to do with "truth," with conviction concerning the nature of a portion of "what is." Obviously the metaphysical realist seeks and believes that to some extent he can possess a knowledge of nature; and though the various forms of skepticism give a limited meaning to "knowledge" and to "what is," the scientist — whether implicitly a realist or skeptic — believes that his method establishes positive truth which will orient him properly to experience. In respect to the existence of God, the religious man is, in effect, a metaphysical realist: his conviction is that God is real; that between man and God there is a genuine relation; and that, in part, the nature of God and of this relation can be known. If empiricism cannot establish its conclusions with certainty, the same — *mutatis mutandis* — is true for religion, and in both science and religion there is the possibility of the correction of error and the growth of insight. Science is the progressive discovery of the characteristics of nature; the life of the religious individual involves the continual increase of his insight into the nature of the moral ideal, of his capacity to make choices in terms of the ideal, of his wisdom in bringing the ideal in its

generality to bear upon the particular in its uniqueness, and, most significantly, of his understanding of his relation to God.

Particular conclusions of science, where it is not the case that both their truth and their falsity are compatible with the religious interpretation of man, must either corroborate that interpretation or be in contradiction with it. Given the function of the individual's moral nature as a necessary instrument in the comprehension of the religious, such scientific discoveries as might appear to corroborate religion will have no primary religious significance. Since religious insight is given to the individual whose will is held taut in the devotion to whatever moral insight he believes he has, no specific scientific discoveries, no cosmological speculation, and no historical documentation of the New Testament are necessary instruments for the attainment of religious belief. If it were not so, then the possession of religious insight would be the privilege of the few who also possess intellectual cultivation and learning. Religious insight would then be one of the differential goods which separate men; it would not be what every religious man knows it to be — a possibility for all.

Scientific conclusions which contradict particular convictions of religion indicate, obviously, the presence of error or of incomplete understanding either in religion or in science, and a great deal might be written on the possibilities for error which analysis can find in the epistemology of religion. Religion's most important errors, of course, occur, on the one hand, in its assertions concerning the nature of the physical world and, on the other, in its assertions concerning the nature of God and of man's relation to God. It is errors of the first sort which are corrected by scientific investigation; though naturalism accepts the *non sequitur* that since science has corrected some of what religion has asserted concerning nature and man, we ought to admit as significant conclusions only those which have been established through scientific investigation. The individual who chooses to live his life in religious categories, but who also, as a thinker, wants to express his religious conviction in a complete world-view faces a speculative task of synthesizing his religious insight and his acquaintance with nature. Significant insight concerning God and religion will reflect the moral and religious development of the thinker himself. On the other hand, all reflection concerning the physical world must borrow from whatever limited understanding of nature is currently available and cannot but reflect its errors.

Of course, it is a commonplace that science, too, has its errors, as does that metaphysical speculation which uses the conclusions of science to go beyond the restricted area of scientific research. Any wholly mechanistic interpretation of the human self, for example, as well as all metaphysical naturalism, is, in effect, metaphysical speculation which constitutes a denial of the truth of religion. Contemporary thinkers who are interested in the nature of the human self, however, can profit from the epistemology of the recent developments in the study of matter. Here we have learned — as we have not yet learned in our study of the human self — to

include in our investigation all available evidence; to challenge even those assumptions whose falsity would seem to be contrary to our most deeply-rooted common sense experience; and to introduce speculative categories different from those of the immediately given.[7] I do not desire to suggest that the categories of contemporary physics are those of the human self, but I mean to raise the question whether the human self will be found to be less complex than matter and whether it alone among the objects of empirical investigation will hold no surprises for the investigator.

In conclusion, there is the naturalist's conviction that religion ought to give to empiricism in the natural and the social sciences the tasks in respect to which it has failed, tasks posed by a society and by individuals in need of help. Religion, however, insists upon the significance of the distinction between the knowledge of nature and of generalizations concerning human activity, on the one hand, and, on the other, the values in the light of which alone knowledge of nature can be properly used and human nature and activity rightly assessed. It is the task of science to study nature and to study man in relation to natural laws. It is the task of religion to make explicit the content of the theologically-grounded values and to emphasize the individual's responsibility for his own moral development in relation to these values. It is the task of the individual to use whatever knowledge of nature his generation makes available to him, guided by his insight into the religious ideal, an insight that will increase in proportion as he strives to appropriate its values. Only the morally earnest individual in his appropriation of the values of Christianity can discover — and in his life can reveal — the truth and the perfect adequacy of Christianity.

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[7] I have in mind such theories concerning the nature of the self as are supplied by positivistic analysis, behaviorism, and the various forms of the "emergent theory." Each of these theories attempts in its own way to explain the self wholly in terms of certain categories of the immediately given. Also each of them fails to incorporate into itself some relevant experiential data and yet fails to explain those data as illusion.

On Relating Science and Religion

HAROLD K. SCHILLING

Part I. Their Actual, Experiential Complementarity

The Basic Problem

> When we consider what religion is for mankind, and what science is, it is no exaggeration to say that the future course of history depends upon the decision of this generation as to the relations between them.
>
> — A. N. Whitehead [1]

We do not know of course just how Whitehead would appraise the urgency of the situation today, but I suspect he would say, at the very least, that the need for meaningfully relating science and religion has not diminished since he wrote these challenging words. It is often said that the "warfare" between science and religion is over and that we no longer have any problem of "science versus religion." While this is doubtless true for many people, for many others there still exists serious tension between them — so much so that they find it extremely difficult to fit them together reasonably into a defensible, consistent over-all philosophy and world view. The basic difficulty they seem to sense does not center in the well worn questions about miracles, virgin birth, creation versus evolution, and the scientific reliability of the Bible, but in what appears to be, on the one hand, an utter incompatibility or incommensurability of science and religion and, on the other, a definite inferiority, impotence, and uselessness of the latter. Our thought patterns today are dominated largely by those appropriate to the kind of knowledge that comes to us through the natural sciences. It has become difficult therefore for us to see how there can be any other kind of "knowing," or how anything can be "perceived" if it is not observable by means of instruments. We find it hard to imagine any reality not found in matter and radiation, and to conceive of any legitimate way of discovering and describing truth other than by means of experimentation, formal logic, and discursive language. To many people, therefore, religion and all it stands for, its insights, methodology, and language, seem not only utterly meaningless but from the scientific point of view both incredible and discredited.

The fundamental issue then is this: Does the universe include any reality other than that recognized by the sciences? Are there legitimate ways of think-

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[1] Whitehead, A. N.: *Science and the Modern World*, New York: Macmillan, 1926 p. 260.

ing and communicating other than those employed by the sciences? May we believe anything to be true that has not been proved "scientifically"? Only in so far as we can find satisfactory answers to these questions shall we be able adequately to relate science and religion. My position is, of course, that these questions must be answered affirmatively. While I recognize that I cannot provide the final answers, I suggest that philosophically final answers are not necessary for present purposes. What *is* necessary is that we recognize first of all the basic truth expressed simply but beautifully by Whitehead in the following profound observation:

> When you understand all about the sun and all about the atmosphere and all about the rotation of the earth, you may still miss the radiance of the sunset.[2]

At first glance these words seem trivial. Actually, however, they are deeply penetrating, for they suggest that our problem lies at the very foundations of knowledge: man's elemental abilities — and *inabilities* — to see and hear, to know and understand, to experience and live, to be sensitive and responsive to reality beyond himself. But, more than that, they remind us of what all of us must surely realize in our more thoughtful and uninhibited moments that there is much more to be seen in the sunset than is revealed through the eyes of natural science.

My thesis has two parts. First, I hope to show that science and religion are experientially complementary, in the sense that they are both deeply rooted in life, that each has something to offer that is unique and indispensable, that each at its best enriches the other, and that therefore life and truth would be incomplete and unsatisfying without the contributions of both. Here I shall rest my case frankly on empirical rather than on more formal logical or metaphysical considerations. I shall then suggest that any philosophy or view of life and the world which does not relate science and religion as genuinely complementary is therefore inadequate and untrue to the facts of experience. Second, I shall consider some methodological problems that inevitably arise when, having recognized their experiential complementarity, one attempts to relate them rationally or philosophically.

Three Facets of Man's Experience

If we ask what reality there is in the sunset that is not perceived through our senses or revealed by instruments and is still not an illusion, one answer is simply, yet profoundly, that there is its radiance. Just what meaning Whitehead wanted to convey explicitly by the term radiance I do not know, but I feel sure that we shall not do violence to his intent if we let it suggest to us a variety of meanings.

[2] *Ibid.*, p. 286.

Reflection reveals that man's experience down through the ages with sunsets has had at least three facets, and suggests that these have resulted from man's contact through the sunset with different aspects or components of his environment — different orders or levels of truth and reality. First, there is the so-called "physical" sunset, that "seen" by the physicist. It is a remarkable sunset, though an "abstracted" one. It is not the natural sunset of colors, hues, and bright hightlights but a rather artificial one referred to in terms of wave lengths, frequencies, and intensities, of indices of refraction at various altitudes in the atmosphere, and of other technically significant quantities. It is abstracted, or extracted, from the total actual sunset, the residue left over after everything that is irrelevant to the purposes of physics has been squeezed out and thereafter disregarded. It is out of man's need to explicate this kind of experience with sunsets and rainbows, with atoms and stars, with flowers and birds that the sciences have arisen.

Then there is the artist's and poet's sunset. Here we encounter the aesthetic experience — experience with structure and form, rhythm and symmetry, line and color, harmony and beauty. This too is "abstracted" from the total sunset. It is different from the physical sunset, but it is no less real; indeed in many respects it is more real — and certainly more meaningful and precious. Would anybody deny that he who sees the beauty of the sunset and sings about it knows, really *knows* with certitude, much more about it than he who thinks only about the wave lengths and frequencies of its electromagnetic radiation? It is out of man's experience with and response to this realm of the aesthetic that there have emerged the arts and literatures of the world.

There is a third facet of man's experience with the sunset, namely, that understood, for example, in the heart of the unlettered peasant who at sunset ceases his toil in the field and while the Angelus bell tolls reverently bows his head in worship, knowing that he is in the presence of the holy. It is the part known quite as well also by the accomplished intellectual who has encountered and responded to the holy under the stars, in the laboratory or in the sanctuary of worship. It is mankind's experience down through the ages with the realm of the holy that is the empirical basis of the religions of the world.

Of course, this threefold experience which men have is not confined to sunsets. There are many experiences in life which clearly have the same three components. Consider man's triune experience with the stars. The astronomer is professionally interested in their positions, distances, magnitudes, intrinsic intensities, motions, spectral types and so on. The artist becomes engrossed in the various elements of their beauty. The Psalmist finds that the heavens declare the glory of God. Many, many men definitely experience all three. All men, I believe, have the capacity of experiencing all three, though in varying degrees.

Consider also the experience of looking through a microscope. Clearly the complicated diffraction patterns observed there reveal a physical world describ-

able in the language of mathematics, physics, and chemistry. Equally real is the encounter there with a world of indescribable beauty. Anyone who has looked through a microscope knows that the sudden encounter there with a new unexpected world of exquisite form, structure, color, light, and shade often is so real that it comes with the impact of an aesthetic shock. It makes one gasp. It takes away one's breath. Just as real also can be the encounter there with the holy, with God. This, too, can be an overwhelming experience. No doubt, it was this experience, this encounter with the divine, that impelled Pasteur to pray and worship in the laboratory and that has impelled many other men to do likewise.

This threefold experience is mediated to us not only through nature, or through things, but also through persons, in fact, most of all through persons. Thus many a psychologist and sociologist has found that his experience with men and women — be it in the analyst's clinic or in the stark, ugly environment of city slums — has yielded not only the bare data of physical existence, but also unmistakable evidence of an aesthetic world and of the pervading presence and reality of the sacred and holy. Or consider the remarkable experiential realm of marriage. Fortunate is the man — and many men have been so fortunate — for whom marriage to a lovely woman has opened up and revealed new, hitherto unrealized depths and heights of reality in the physical world, the world of beauty, and the world of the divine. For Christians the greatest and most convincing evidence that the encounter with the holy and divine can be mediated through persons lies in Jesus Christ — in whom God became incarnate.

Does it not seem proper to say that only he really sees *the sunset* who experiences all aspects of its reality and thus sees it in all its glory, who knows it with the insights of the scientist *and* the poet *and* the saint? Surely to see its radiance must mean to see more than its physical aspects and to see it with all of one's faculties for perception. And so it is with the stars and the mountains, the water drop seen microscopically, or the inside of the atom seen mathematically, and most of all with human beings — with all of life, the world, and truth: to *know* them means to know them in all ways and in all aspects of their reality.

This suggests one approach to the problem of relating science and religion — and art. It is to recognize that all three spring out of and are concerned with man's experience, with what they *know* as the result of that experience. It is to recognize also that each sheds light upon an aspect of life and reality which the others are less able to illumine. There are great realms of truth that we could not possibly know without science. Without the aid of the arts there would be other vast unknowns forever beyond our ken. Similarly, without religion our experience and knowledge of life and the universe would be incomplete. All three are indispensable to full insight and knowledge. Together they contribute to and make possible the full life; and they come out of the full life *together* in response to the manifold fullness of reality beyond, around, and within us.

Some Basic Concepts

We should now digress to consider a few questions which critical readers must be asking at this point. In what sense have we been using the terms reality, holy, religion, experience? They have, of course, been commonly used in many senses, but I shall indicate only the meaning I have attached to them here without attempting intricate philosophical discussion.

When I speak of reality I refer to those aspects of our experience and environment which are actual, reliable, trustworthy, and not illusory. Our concern is that we shall not fool ourselves into thinking that something "really" exists, when actually it doesn't. I have, then, in this discussion considered something to be real when it presents itself to ordinary "normal" persons (though not necessarily to all such persons) compellingly and coercively as something *given* and existing independent of their own wishes and to which they feel the strong urge to respond or react in some existentially significant way. There is a *must* about it. Thus when we look at the sunset we feel that we must accept it as being there, that *it is there* whether we are or not. It is not the product of our wishes. In short, we say *it is real.* For physicists certain of its aspects are especially convincing and irresistibly, compellingly given, namely, those measurable by instruments. They respond to this reality with thought, analysis, experimentation, and theoretical creation. Artists and others find that the beauty of the sunset thrusts itself upon them and is real. They are quite sure that this part of the sunset is not of their doing but is convincingly "in nature." They respond to it in urges to depict and interpret it in art forms.

This then brings us to "the holy" experienced in the sunset. The holy may be thought of as *that* in our "environment" to which men have responded down through the ages in worship and prayer, faith, reverence, whole-commitment, and God-dedicated deed. In this part of their experience also men have been conscious of a reality compellingly and convincingly impressing itself upon them, filling them with awe as before great majesty, illuminating their souls, irradiating their thoughts, motivating their actions, quickening their consciences, drawing them into I-thou relationship to God. It must have been this experiencing of the holy that caused the Psalmist to burst forth with "The heavens declare the glory of God." No doubt this was the experience of Job when he heard the voice of God in the whirlwind and of Moses when he encountered the burning bush that was not consumed. It is the experience of many men who in laboratory or field are conscious of being in the presence of the holy. By the criterion of reality used here, the holy is then a realm of reality as truly as are those of the physical and aesthetic. All three are given and are objective in that there is a compelling must about them, which is experienced as being in a sense external to and independent of the observer.

One of the difficulties with the use of the word "holy" is that it is largely a forgotten word. Popular religion has come to be synonymous mostly with ethics and beliefs. Religion, even Christianity, is commonly said to mean to be good and to subscribe to religious beliefs. But this view is tragically inadequate. Fundamentally, religion transcends both ethics and epistemology and goes far beyond the good and the true. It takes man into the realm of the holy. All the great religions of the world have consistently demanded and offered much more than goodness and truth, namely holiness, and direct experience with the holy and direct "knowledge of" God. And this is what I mean basically by religion, this awareness of, sensitivity and response to, and the I-Thou relationship with, the transcendent, holy God — together with all the consequences that flow out of it in human relations.

At this point we must recognize at least two different usages of the term religion that are pertinent to this discussion. The first treats it as a *part* of life, while the second regards it as embracing *all* of life and being concerned with all of reality. There are those who insist on an either-or point of view about this. My own position however, without trying to justify it now, is that both usages are proper and that each offers its own insights without which our understanding of religion would be inadequate. I feel that it is meaningful to say that science, art, and religion each offers its own experience and knowledge, has its own domain of special interest and competence, and employs unique tools and methods appropriate to that realm. Each has its own modes of thought, its own ways of arriving at truth, its own language and means of communication. Just as for a carpenter a saw, a plane, and a hammer have different purposes, so in life science, art, and religion have different purposes. Certainly if we want to learn about the behavior of gasses under varying conditions of temperature and pressure, we do not go to church or read a book on theology. Nor do we engage in worship to discover the artistic attributes and values of Shakespeare or of a Rembrandt. There *is* a sense then in which religion represents only one kind of experience and is only one among various ways of knowing and understanding — and therefore is only a part of life.

Just as truly, however, religion also spans all of life. The history of mankind has shown that there is no aspect of reality that cannot become the medium through which the holy is experienced and God glimpsed and no part of life where religious motivations, commitments, and attitudes do not have profound effects. This is, of course, to be expected if we believe, as the Christian does, that God has made and now sustains the physical, aesthetic, spiritual, holy, and all other aspects and realms of the one all inclusive reality. Surely this is what Paul must have meant when he burst forth with the following remarkable rhapsody while writing his letter to the Romans: "O the depth of the riches and wisdom and knowledge of God! How unsearchable are his judgments and how inscrutable his ways. . . . For from him and through him and to him are all things."

(Romans 11:33,36) There can be therefore no contradiction in saying that religion is a part or aspect of life and experience and yet is also concerned with and comprehends all of it.

Science, Art, Religion Complement One Another

I would urge that, if the Judaeo-Christian conception of the unity of knowledge and experience is correct, it should follow that science, art, and religion are complementary in that they interpenetrate and interact existentially in their concerns, interests, and attitudes. Just as there is no area of experience which cannot take on religious significance, so there is nothing in life excluded from the artistic perception or illumination. And it is doubtful that any experiential happening is altogether beyond the horizon of scientific interest and the need for its critical scrutiny.

Science itself cannot be adequately appreciated unless its artistic and creative aspects are understood. It is doubtful that it can be understood truly as a phenomenon of history or a component of culture unless the effects religion has had upon it are taken into account. Similarly, religion will not be fully meaningful to us unless we appreciate the extent to which it is spiritually and conceptually in debt to both art and science. The fact is that in the rich and inclusive, full life they are inseparable. Therefore, it seems proper to say that our artistic and religious quests should in the very best sense be uncompromisingly scientific, our scientific and religious endeavors genuinely artistic, and our scientific and artistic pursuits and dedications truly religious. In this way — and perhaps only in this way — will we be able to experience and understand in its fullness either what each of them is uniquely most able to shed light upon or what can become truly meaningful only when illumined by them all. Only then can all knowledge and all experience glow for us in full divine *radiance*. And then we will ***know*** with deep insight and conviction that science, art, and religion — as indeed also other disciplines and modes of penetration into the unknown — are *all* handmaidens of the Lord. And thus we shall have related them to each other positively by assigning to each its own proper role and function in the whole experimental scheme of things, each as a unique part and at the same time a universal dimension of the whole.

To summarize what has been said so far and to relate it to the basic issues I have undertaken to discuss, I have suggested that mankind has in its actual experience encountered different aspects of reality, including the physical, aesthetic, and the holy. These are experienced as given and objective. Man's response to these is expressed in science, art, and religion. To the Christian all the world is God's. For the Christian science, art, and religion are different modes of exploration of different components of God's world and at the same time different attitudinal approaches to all of it. Therefore, they should be thought of as complementing one another — as partners, not competitors or antagonists.

About Experience

In all this I have without apology employed the term "experience" with a common-sense meaning, though I would certainly insist that critical thinking and analysis is an indispensable ingredient of experience at its best. I have tacitly assumed that what we experience is knowledge and therefore that there are reliable ways of finding knowledge other than those used in science. I have assumed that man is not only a thinking being but that he is also a creative being and a worshipping being; that as a man reasons or creates artistically or worships he learns, and that what he thus learns is real and has meaning.

We must now look at another aspect of human experience. Up to this point we have spoken almost exclusively of individual experience and of what the individual may himself come to know. It is true, however, that while both science and religion certainly are concerned with the experience of individual persons, mine and yours, this is by no means their only concern. Both are fundamentally interested also in social or communal experience, i.e., in what is experienced by and happens to groups of people, especially groups bound together by ties of "like mind" and common commitment. Both are dependent for their existence and growth upon a communal "sharing of experience." Neither of them regards an experience of a particular individual as of great interest or importance if it is "unique" and therefore not typical of the kind others also can have and understand. In other words, we must qualify what we have said earlier by pointing out that what a man learns through reason, artistic creation, and worship is accepted in science, art, and religion as real and meaningful only if it "makes sense," if it is consistent with and can in some way be understood in terms of what has been experienced and thought communally. If a scientist were to claim that he had seen pink elephants, a triangular moon, or isolated magnetic ions, but no one else ever had, the science community would doubt the authenticity of his experience as a revelation of the reality of such objects. Similarly, an allegedly religious experience of "vision" of a kind unknown to or inexplicable by the religious community would not be regarded as authentically revelatory of truth and reality. Herein, in interpersonal crosschecks and communal acceptance, lies the basic rationale of the confirmation, validation, and authentication of both scientific and religious truth. And here in "intersubjective testability"[8] we encounter what seems to me to be the most basic meaning of "objectivity."

There is another sense in which communal experience is significant to science and religion. Not only are they concerned with experiences that individuals can have and cross-validate for each other, such as seeing color, hearing sound, being conscious of the holy at sunset, but also in happenings experienced by groups,

[8] A term suggested by Professor Herbert Feigl; cf. Feigl and Brodbeck, *Readings in the Philosophy of Science*, New York: Appleton-Century-Crofts, 1953, p. 11.

communities, and peoples as a whole such as the flood and the hurricane, the harvest, the finding of refuge and the winning of independence, the impact of prophetic utterance and the turning from idolatry, the atomic explosion and the financial panic, the revelatory gaining of new insights, the reformation, and, most of all, the historical "events" called Moses, Mohammed, Christ, St. Augustine, Newton, Luther, and Abraham Lincoln.

All such events are experienced and interpreted in various ways. For one thing they may be known and responded to from within or without. All of them have an inner and outer history and significance. Each looks different to participants than to mere onlookers. Sherman's march through Georgia seems very different, even today, to the native Georgian than to the Pennsylvanian; and the invasion of Pennsylvania (at Gettysburg) feels different to a Pennsylvanian than to a Virginian. The atomic explosion had for the Japanese vastly different experiential content and interpretive meaning than for Americans; and within the physics community it had still different significance.

Events of this sort also have scientific, religious, and other dimensions just as do the sunset, the stellar sky and the burning bush. All of them certainly have physical dimensions, are experienced physically and interpreted at least in part in terms of natural laws and other categories of the natural and social sciences. And all of them have been regarded widely, both primitively and interpretively, as the works of God. As truly as man has down through the ages persisted in seeing God beyond the stars so he has incorrigibly persisted in seeing God in historical events. Not only have men worshipped in the presence of the holy experienced through the rainbow, but they have worshipped also, and quite as consistently, in response to the historical event thought to have dimensions or components transcending the "natural" and the social orders. And they have done so because of a compulsion from beyond, a coercive must that has been utterly convincing, a compelling consciousness and awareness of the holy and divine making itself known through human affairs and impressing itself causally upon the movement of history.

Theology certainly has been concerned with interpreting not only personal experience but also communal experience. Indeed Christian theology (at least in some of its contemporary manifestations) seems to emphasize the latter and more particularly the experience of the Church. Its primary data seem to be the great events of Judaeo-Christian history and the response of man to God experienced communally through these events.

It should be emphasized then that this discussion has dealt with both individual and communal experience and that the complementarity of science and religion is asserted with respect to both of these aspects of experience. Again I urge that both individual and group experience are responses to various facets of reality and that our knowledge of both nature and history must necessarily

be incomplete without the unique but complementary contributions of science *and* religion. Each provides insights the other cannot offer.

PART II. Obstacles to Formal Conceptual Complementarity

The Problem

We must now face the fact that science and religion certainly have not always seemed complementary. If our thesis about them is correct, if they do indeed belong together and are not competitors, why has there been so much tension and even warfare between them? I shall attempt to develop only a partial answer along the following lines. Both science and religion have experiential and theoretical or interpretive aspects or levels. At the level of basic, perceptual experience there is no contradiction or conflict. At the level of theoretical interpretation, on the other hand, tension is almost inevitable, and here is where most of the difficulties arise. An analysis of why this is so should help us to reduce such conflict to a minimum and to achieve a more satisfactory rational or philosophical relationship (as distinguished from an experiential relationship) between science and religion.

As we undertake such an analysis we should realize at the outset that an attempt to relate science and religion *philosophically* is in its very nature different from seeing how they are related *empirically*. It is mainly a process of putting ideas together, of fitting them into place in one's thinking, rather than a looking about to discover any relationship which may already conceivably exist in some objective sense. It is a typically "theoretical" sort of endeavor, a matter of active decision more than of passive acceptance. From time to time, as our knowledge, methods, and conceptual milieu change, the possibilities of new relations must be considered and new decisions made. There are many reasons for this, of which I should like to consider only five at this time.

Partial and Partitioned Knowledge and Methods

In the *first* place, the business of dividing our total intellectual and spiritual quest for truth and our study of the universe into various "disciplines" or "fields" such as science, religion, art, history, and philosophy is an artificial, categorizing sort of undertaking made necessary by our inability to think successfully in terms of entireties. Life, being, truth, the world, man, society actually exist only as unitary wholes. When however we look at these wholes we discover that it is impossible for us to see or think about them except only by parts and from particular points of view. This is why we must dissect and classify and give partial descriptions. This is why we persist in making dichotomies such as the animate and inanimate, the material and spiritual, the internal and external, the objective and subjective, the personal and impersonal. Unfortunately, this partitioning,

though it is inevitable, almost always leads to trouble sooner or later, for as this process goes on the existence of the consistent whole tends to be lost sight of. Moreover, our knowledge of the parts usually grows at different rates and becomes related to different interests. Consequently, the parts take on the appearance of being unrelated and independent and often even paradoxical, and soon we have on our hands a whole array of ominous "problems" which are caused not by the actual nature of things but by our splintered views, our inadequate modes of thought, approximate definitions and concepts, and lack of overall perspective. This on a grand scale is the situation in which we are enmeshed today. It explains, at least in part, why science and religion so often seem paradoxical. Each has become a partial view or experience which seems unrelated to the other; we no longer see them as belonging to the same whole. We have lost sight of the fact we have called attention to in Part I, namely that science and religion are actually complementary aspects of man's response to reality.

The only way we can extricate ourselves from such a situation is to retrace our steps, to see how we got ourselves into trouble, to put the pieces together again, to see what the original pattern of the whole must have been — or *is*. This may require reshaping theoretical pieces that no longer fit, redefining partial concepts, creating new ways of observing and thinking that will achieve better perspective and more complete comprehension of the whole.

There is *another* reason for the necessity of actively manipulating our concepts and choosing meaningful relationships of the parts of the whole. Not only are we unable to handle totalities intellectually, but they almost never exist *for us* in the first place. The universe and various of its entities present themselves to us at any given time only partially. Therefore, our thinking is based almost always upon incomplete sets of data. If we then apply such partial thinking universally, as we seem inevitably to do, we usually encounter apparent paradox and contradiction — even though such contradiction does not actually reside in the nature of things. Many of the problems of "science versus religion" have in the past come from conclusions based on incomplete scientific or religious knowledge.

A *third* difficulty arises when the methods used in exploring a particular part of the whole turn out to be especially successful. The temptation then becomes very strong to suppose that they are valid universally, to project their use into domains for which they were not designed, and to assert others to be inferior. This is, of course, like saying that because a saw is very sharp it is superior to a hammer because the latter is not sharp at all. Much tension in the past has been due to the improper application of theological methods, successful in their own sphere, to problems in science. Today similar tension results from the improper assertion of the universal validity of scientific methods.

In view of these dangers we must guard against tendencies to exalt partial views, knowledge, and methods, to give them dominating status, and uncritically

to accord them the roles of the wholes. We must continually remind ourselves to keep developments within proper bounds and to maintain or re-establish balance and perspective. This is what is meant by relating parts in such a way as to keep in view the whole as much as possible at any given stage of our knowledge.

Experiential Knowledge and Theoretical Interpretation

There is a *fourth* danger which has been a most persistent source of trouble. It is the almost irresistible tendency to assume that when the hypothetical schemes we construct are successful they must therefore be concretely true. To keep our perspective undistorted we must learn to distinguish critically between our actual knowledge and our interpretations of it, between what we observe to be true experientially and what we think theoretically. This is not always easy — especially since no sharp dividing line can ever be drawn between the two.

To make this clear let us consider a few typical questions that might arise in a physics class. What is an electric current? There are at least two answers: first that it is the flow of electrons in, say, a wire; the second, very different, defines it as the condition a wire is in when it is connected to the terminals of a battery, is hot though not heated by a flame, is surrounded by a magnetic field of a particular kind, and so on. Suppose we next point to a wire and ask if there is an electric current in it. Which of the definitions is most helpful in answering this question? Clearly, the second. Why? Because it enables us to use what we actually *know* directly or can find out empirically. The first is a theoretical interpretation. It is not directly useful in operationally answering our question about the concrete situation.

What is light? To say that it "is" waves is to give a theoretical, interpretive answer. The same would be true if we said that light consists of particles called photons. On the other hand, to speak of it as a form of radiant energy that can be propagated through a vacuum, that can be absorbed, reflected, refracted, and diffracted by matter under certain circumstances and with certain results is to give an answer in terms of empirical knowledge.

To say that the moon gravitates toward the earth with an acceleration which is directly proportional to its mass and inversely proportional to the square of its distance is to make a statement of what we *know*. To say that it thus gravitates because of a postulated force of gravity which is proportional . . . is to make a much more interpretive and theoretical statement. To assert that it gravitates toward the earth because of the curvature of its geodesic, using Einsteinian language, is likewise to make a theoretical statement which says less about what we know than about how we interpret what we know.

In making such distinctions we are making value judgments about the relative merits of the empirical and theoretical components of science. The purpose

of theory in science is to describe systematically, to explicate, to generalize our experimental findings, and to help us to think of new possibilities and thus lead to new research. Therefore, it is extremely important and in fact indispensable. On the other hand, if there were no empirical knowledge, there would be nothing to theorize about. Progress in science becomes possible only through the continual interaction of experiment and theory, experience and interpretation. While both are thus indispensable, it is nevertheless essential for many reasons that we distinguish between them.

The situation in religion is, as I see it, essentially the same. Here too we have both the experiential or empirical and the interpretive or theoretical. The latter is called theology. It too represents the attempt to describe systematically and to explain the facts of experienced religion. Perhaps its greatest value lies not only in that it helps us to think about our religious experience and to communicate with one another about it but also in that it can lead into hitherto unentered realms of experienced reality.

The history of science is twofold. It is a history, first, of the growth of empirical knowledge and, second, of the evolution of conceptual schemes devised to interpret such underlying experiential knowledge. The first is in a sense an account of the development of the permanent elements of science, that which succeeding generations of scientists accept as empirically verified, while the second depicts the flux of the more impermanent parts of science, those representing interpretations that serve their purpose and then give way to more useful notions and ways of thinking as time goes on.

Similarly, the history of religion is twofold. First, it is the history of man's experiential relation to God, a gradual unfolding or accumulation of new religious experiences. Second, it depicts the development of man's ideas about God and things divine and about man's experience with them. Here as in science we find a changing flux, a continual modification or even replacement of the old by the new. Thus our concepts of God have had to be changed many times in order to conform them more closely to man's growing experience with Him. This happens apparently in all religions. In Christianity, for instance, it required several hundred years before the evolving doctrine of the Trinity became acceptable to most of the Church as an adequate interpretation of what had actually happened to it in its historical experience with God.

Unfortunately, in both science and religion men tend to confuse or fail to distinguish between empirically known and theoretically created knowledge and tend to think of the latter as solid truth — rather than imagined, symbolic representation of truth. This has been a serious obstacle to progress in both fields. Moreover, essentially all the warfare between them has been at the theoretical level — a conflict of interpretations. Just as artistic experience never directly contradicts scientific or religious experience, so experience in worship and prayer

never contradicts what is experienced in laboratory or field. Any appearance of contradiction arises in the act of interpretation.

The lesson to be learned is that when we get into impasses or encounter apparent contradictions we should first of all look to our interpretations as the source of difficulty and always be prepared to rethink and restructure our concepts, doctrines, and theories in the realms of both science and religion in order that they may better represent the facts and realities of life and existence as they have been actually experienced.

Some Intellectual History

Now let us look at a bit of history. The evolution of conceptions of the astronomical heavens illustrates rather well the difficulties that come from unjustifiable reliance upon partial and partitioned knowledge, the tendency to make universal claims on the basis of insufficient evidence and inadequate method, and from mistaking scientific and theological theoretical constructs for truth. It is a story in four parts, each with its own cosmological system: the pre-Ptolemaic with its flat earth and arched dome "heaven;" the Ptolemaic with its epicycles and geocentric crystalline spheres; the heliocentric Copernican; and the contemporary cosmology. In each case the change-over from one to the next involved the same four basic difficulties.

The pre-Ptolemaic era lasted a long time — and for good reasons. The conceptions of those days accounted very well for the relatively few facts known only by direct naked eye observations: a somewhat flattened celestial sphere resting on the earth at the horizon, and lights attached to that sphere.

Acceptance of the so-called Ptolemaic geocentric system was slow because the earlier idea, though based on partial knowledge, seemed self-evident from a common sense point of view and because the new concepts of spheres and epicycles seemed too complicated. Eventually, however, it won its way because, first, it made possible the prediction of astronomical events such as eclipses and, second, provided an aesthetically and philosophically satisfying picture of facts not known earlier. Indeed, it became so successful in explanation and prediction and remained so for so many centuries that it came to be regarded as ultimate, *a priori* self-evident truth, just as had the former ideas. It was altogether natural then for philosophy and theology to amalgamate it into cosmological thought systems and to build upon it better concepts of God, heaven, and hell. The poets, such as Dante, did likewise. It all made sense at that time from almost every point of view.

Then, after almost fifteen centuries of intellectual peace and quiet, came the astonishing astronomical discoveries made possible by Galileo's new telescope. Many more stars appeared than could have been seen with the unaided eye. The moon was seen to have mountains and valleys and to shine by reflected light,

rather than by its own. The planets turned out to be spheres. Satellites put in their appearance. Sun spots were discovered and their motions showed that the sun rotates on its axis. All this seemed nothing short of incredible. It soon became painfully doubtful that the new facts could be fitted into the old Ptolemaic theoretical structure, and naturally that made serious difficulties — for both scientists and theologians, as well as poets and philosophers.

Looking back, we now realize what these difficulties were due to, basically. They came from unjustifiable over-commitment to the earlier theory, i.e., to the tacit assumptions that it encompassed the whole universe, whereas it didn't; that it was true, rather than only a useful mental construct; and that it had theological and philosophical sanctions which, of course, it could not have legitimately.

Whenever radically new facts come along and challenge an established system of thought, there ensues inevitably a period of great tension. As is altogether proper, every effort is made to modify the prevailing theory to accommodate the new arrivals. At the same time, new theoretical ideas put in their appearance. The new and the old are subjected to severe critical analysis and weighed against each other. The new is resisted stubbornly to conserve the old and tried. All this, of course, is accepted as desirable and necessary in both science and theology — as in all other areas of scholarship. And this is exactly what happened when the Ptolemaic system was being challenged by the new facts. Scientists and theologians alike were critical of the new and struggled to keep the old.

Finally Galileo came to see that the new knowledge could be handled successfully if a heliocentric theory put forward by Copernicus, on what we would today regard as philosophical rather than scientific grounds, were modified along lines suggested by Kepler's remarkable mathematical theory of planetary motion. Unfortunately, after he became completely convinced of this, Galileo made the same mistake that his predecessors had made, namely, that of supposing that because the new theoretical system was highly successful, it must necessarily be true as a factual description of the actual astronomical world. Here is where the big battle was joined. Some of his most distinguished colleagues and contemporaries — fellow scientists, as well as theologians — felt that the new scheme, whatever its hypothetical value and success, should not be regarded as *true;* and this became the official position of the Church.

To make a long sad story short, while Galileo lost his personal battle, his views won out in the protracted war. Unfortunately, the world eventually accepted the heliocentric theory as being *true,* and so the situation remained for centuries — until very recently. Indeed many people do not realize even now that ***it has changed.***

The fact that our attitude toward the Copernican scheme is indeed very different from Galileo's and from that which has been scientifically orthodox until fairly recently was brought home to me with a veritable shock — administered by a very distinguished and able teacher of mine, Professor Robert A. Millikan then at the University of Chicago. One day in a graduate course he asked the following innocent sounding question: "Which is *true,* that the sun goes around the earth or the earth goes around the sun?" The class replied unanimously that, of course, since the days of Galileo the earth has been ***known*** to go around the sun, rather than the sun around the earth. To which he replied in essence as follows: "Gentlemen, you are wrong. The only correct answer is that ***we do not know*** which is *true,* if we refer to absolute truth. It is just as correct to say, that the sun goes around the earth as to say that the earth goes around the sun — considering the motion of each as relative to that of the other. How they really, really move in an absolute sense we do not know and have no hope of ever knowing."

The New Outlook in Science and Theology

This insight, expressed so pointedly by Millikan, and the whole new attitude toward knowledge that goes with it are becoming increasingly prevalent today in both science and religion — and this development represents a revolution in thought quite as momentous as were the Ptolemaic and Galilean revolutions before it. Let us look briefly at some of the aspects or components of this new outlook and try to see what its significance is for our problem of relating science and religion.

In the first place the increase in empirical knowledge of the physical universe has been tremendous. We now talk of millions of light years and of galaxies, about the temperatures and chemical constitution of the stars. We know that both the emission and the propagation of light are affected gravitationally. We speak of the "expansion of the "universe" and are puzzled by it. Mass and energy are now transmutable and we are considering the possibility of continuous creation and annihilation of matter-energy in astronomical space-time.

It seems quite evident, as one studies the literature, that in view of the rapid and voluminous increase of knowledge ***we are not now and probably shall not be for a long time to come in danger of supposing that our present knowledge represents all or nearly all there is to be known.*** That is, we are acutely conscious of how little we know. Just before the turn of the century many reputable physicists were saying that about all that remained to be done was to make our already existing knowledge more precise. Those self-complacement days are gone.

With the huge increments of new factual knowledge have come novel modes of thought, new conceptions of knowledge itself. The contributions of Einstein

and some of his successors have given us new insights into the role and meaning of the act of observation. Many quantities, such as mass, velocity, length, duration, formerly thought to be "absolute," are now known to be "relative" to the experimenter's system of reference. Moreover, we now realize that an observer is an integral part of the world he observes, that his observations are part of the phenomena observed, and that these inevitably change in the process of observation. The famous Heisenberg Uncertainty Principle is regarded by some as meaning that the universe operates as a whole, that any attempt to analyze any of its parts in isolation will necessarly yield results that are "in error."

These findings of physics, paralleled by others in biology, psychology, philosophy, and other fields, have made us increasingly suspicious of many of our classical analyses and partitionings which have lead to such dichotomies as matter and energy, space and time, body and mind, subject and object, and others. We are learning to think in terms of wholes, thus *becoming more holistically minded and less likely to forget the whole as we study the parts.*

We are developing a more critical attitude toward our scientific methods and are experimenting with new ones designed to prevent over-extending our methods or using them where they are not suitable. We are very conscious, for example, of the limits and limitations of the use of Euclidian geometry, of Newtonian mechanics and of classical logic. We have emancipated ourselves from the dominance of certain metaphysical notions about space and time, about cause and effect, about the role of mathematics in physics, which for a considerable time made progress difficult. Instead of demanding "deterministic" laws and predictions of the future, we are now content with actuarial forecasting in terms of probabilities. We realize keenly that intellectual devices that are tremendously useful in some fields may be quite inappropriate in others — even within science itself. *We are no longer seriously tempted to claim universality for our methods.*

One of the most important developments in science is that of the operational method and point of view which, while no cure-all panacea, certainly helps us to distinguish significantly between empirical knowledge and theoretical interpretations. *We will be less likely to claim absolute truth for what is only a useful theoretical representation of truth.*

There have been similar developments in religion and theology. Here too men are learning to be wary of partial views, partial knowledge, partial methods and to distinguish between the experiential and the interpretive, the empirical and the theoretical. In theology there is a tremendous amount of research, a vast amount of rethinking, much redefining and restructuring of concepts in order to recapture a more adequate view of the whole and to fit thought patterns more closely to the religious experience of the individual and community. Methods are coming into being that are more potent than the classical ones, and theology is becoming much more conscious of methodological potentialities and limitations.

The Prospect

In view of all this I would claim that the occasions for misunderstanding, apparent contradiction, and conflict between science and religion are decreasing. Many of the old issues and perplexities are disappearing. To be sure, new ones will take their place, but the new knowledge, methods, and attitudes should help us dispose of them much more easily and intelligently than would have been possible heretofore. Furthermore there is, I believe, a growing conviction among both scientists and theologians that conceptual knowledge as well as experience must be unitary and that permanent incommensurability or contradiction between them must not be allowed to develop. This is tantamount to saying that science and religion are in the process of being related rationally or philosophically as complementary components of any over-all world view that may emerge.

Lest however we repeat the mistakes of our forebears, we must keep in mind the probability, or indeed certainty, that no world view or philosophical system we may develop can ever be permanently satisfactory in either its completeness or its internal consistency. It will always be erected upon partial knowledge, partial methodologies, and inadequate overall perspectives. This seems to mean that a complete, rational system or synthesis of science and religion is impossible and that the search for it should be abandoned. Any genuine synthesis that may be possible will, I think, always be experiential, i.e., achievable only in the life of people as they work, experiment, worship, theorize, and learn in contact with each other and with the realities of existence. In terms of my Christian convictions I would say further that such synthesis can be adequate only when it comes into being in the community of men and women whose lives, in all their aspects, are lived in whole-commitment to God — though even there, as I see it, no fully adequate conceptual system of relationships between science and religion is possible.

Perplexing Differences Between Scientific and Religious Experience

There is a *fifth*, perhaps the most perplexing of the difficulties confronting him who would relate science and religion systematically. It arises from two very puzzling differences, which should now be pointed out explicitly, between religious and scientific experience with regard to feelings or convictions of certainty and uncertainty.

First, it is probably indisputable that in science, once a phenomenon or physical effect has been accepted by the science community as empirically confirmed and then incorporated into its conceptual systems, there almost never arises any serious doubt among individual scientists as to its experiential authenticity. In the realm of religion, however, a "believer" quite normally experiences doubt and certainty that alternate disconcertingly and unpredictably, often accompanied by feelings of anxiety and guilt.

The pioneering scientist who has just made an experimental discovery of, say, a new chemical element in the periodic table, a hitherto unknown property of light, or a new physiological phenomenon will, of course, at times experience difficulty in repeating his results and will therefore be very conscious of uncertainty. He may even find it necessary to retract and admit that it was all a mistake. As he develops his techniques, however, and refines his findings his feelings of uncertainty (either that he did or did not find something real) become weaker. Then as his results are confirmed progressively by other scientists he becomes more and more sure of their authenticity. Finally after the pioneering stage has passed both he and the science community become and remain (with rare exceptions) certain and no longer have doubts about it. The knowledge thus gained is permanent. Thus while Priestley, the discoverer of oxygen, had the usual troubles, doubts, and uncertainties in the early stages of his work, both he and his scientific peers eventually attained certainty as to the existence of oxygen. Today, no scientist doubts it. Similarly when Harvey first discovered the circulation of the blood there were many questions and uncertainties both in his own mind and others. Today no one doubts it.

The same kind of experiential certitude exists in science also with regard to certain more general aspects of experience. Thus while the word "nature" conceived in terms of philosophical or metaphysical notions may evoke serious doubts in the scientist's mind as to its reality or existence, it raises no doubts whatever when it refers to what he experiences in laboratory or field. When he is experimenting he is, in attitude and action, an uncompromising realist without any uncertainty as to the existence of physical reality and "nature."

Before considering the analogous situation in religion we should be aware specifically that what we have said about feelings or convictions of the certainty and permanence of knowledge in science applies to its empirical elements but not without serious qualification to its interpretations: its hypotheses, models, and theoretical patterns. Thus, while no one doubts the existence of oxygen and of its chemical properties, the question of its "structure," i.e., of a model that explains its chemical behavior, is quite another matter. Similarly while the reality of radiant energy is regarded as beyond doubt, pictures or models of its structures and hypothetical mechanisms of its transmission are not. As we have said earlier, these interpretive or explanatory devices come and go and should not, at least in terms of contemporary views of the nature and purpose of scientific theory, be regarded as permanent or "certain."

Now in religion the authenticity of some of the most basic elements of experience are typically in painful doubt from time to time in the minds of even the most devout individual believers. *Why* this is so is, of course, one of the great mysteries of existence. That it *is* so, however, is attested by a great mass of biographical evidence and by the history of religion, including that of the Christian

Church. This is recognized explicitly in Christian theology which conceptualizes and explains it in various doctrines as to the nature of man and God. More specifically, the experience of the ebb and flow of one's awareness of the presence of God or of certainty as to one's relationship to God or as to the very existence of God and the empirical fact that God is never "seen" with complete clarity are expressed or conceptualized by the venerable doctrine of the *deus absconditus*. The explanation it seems to offer is that God cannot be seen at all except in so far as He veils Himself and that for various reasons He changes the translucency of the veil (or the "veiling") from time to time.

The second aspect of this fifth difficulty is that in religion the reactions of conceptual schemes upon basic experience are usually much more profound than in science. Unfortunate theological conceptions and formulations may prove to be toxic to religious experience. Undue preoccupation with religious theory in general or with certain theories in particular may cause religious experience, e.g., worship, prayer, love of God, and love of neighbor, to wither on the vine. On the other hand, other theories may greatly enrich and enoble religious experience, heighten one's sensitivity and responsiveness, deepen one's faith, lead to new insights and more complete commitments and dedications. Moreover, without the steadying effect of reason expressing itself in religious concept, religious experience is in danger of drifting in the directions of magic, superstition, fanaticism, or intellectual nonsense. Analogous transformational interactions between experience and theory exist, of course, also in science — though not to the same extent — and out of them arise the same sorts of difficulties and dangers as well as positive values. They are by no means characteristic of religion alone. For present purposes all this constitutes a serious obstacle to attempts to achieve conceptual complementarity between science and religion, for it means that not only do we at any one time always have available only partial knowledge, methods, and perspectives out of which to fashion an over-all world view but that some of the basic mass of experiential data, especially on the side of religion, changes markedly from time to time — in both its actual "content" and the quality of its convincingness.

It should now be emphasized, however, that in some religions — especially in the Judaeo-Christian tradition — the most basic, "rock bottom facts" and "data" that theology endeavors to interpret are considered to be not the "internal" or private experience of the individual believer but the common, historic experience of the people and the Church. While the former kind are indeed disconcertingly variable, the latter are not. I understand that the Church has always taught that a believer's convictions as to truth should not rest or depend upon his own personal experiences (important as these are) or his own feelings of certainty (though these too are relevant) but upon the indisputable historic experiences of the body of believers and that it is the Church's collective conviction of certainty and truth that is to be trusted most. As has been said re-

peatedly, in Christianity it is not only the I-Thou relationship that is fundamental but also — and perhaps even more so — the We-Thou relationship or the I-Thou-We relationship.

A recognition of this primacy of communal experience in the Judaeo-Christian tradition removes much of this fifth obstacle when we are attempting rationally to relate specifically this tradition to science, for it brings to light what is commonly not understood, namely that here in the communal experience of the Church we do have a solid, permanent body of constant experiential data and not only the variable kind that is so evident when we are thinking mostly of individual religious experience.

On Relations by Decision

One other aspect of the problem of relating science and theology conceptually or philosophically should be considered here in conclusion. It is important to recognize explicitly that basic to any attempts to achieve a unified, self-consistent rational system, in which two conceptual structures appear as complementaries, there must be the recognition of the complementarity of those realms of reality and aspects of experience which these structures endeavor to conceptualize. If such empirical complementarity and unity do in fact exist, then they constitute the primary data to which the theoretical or philosophical relations must conform. Until a rational system that is being developed reflects in this way the actual unity revealed by experience it would seem to be inadequate and incomplete.

The implications of these remarks for anyone endeavoring to relate science and religion rationally would seem to be quite clear. First, one should decide whether the evidence is sufficient convincingly to reveal their positive complementarity in experience — in some such sense as I have suggested. If so, one then has a mandate so to structure one's over-all conceptual system that within it science and religion together make sense and have mutually complementary functions. This might require modification of concepts and their redefinition, a shifting of emphases, rejection of certain traditional points of view, or even the formulation of new ones. It would require recognizing that the business of relating science and religion includes more than the discovery of objective relationships that may exist independent of the observer. It necessitates also on the part of the thinker that he make certain decisions as to how he should and will relate them in his interpretive thinking. This is why Whitehead could speak of "the decision of this generation as to the relations between them."

Comments on Professor Schilling's Article

I

Professor Schilling's personal statement on the relating of science and religion is interesting and provocative. As an individual, I find myself in general agreement with his point of view. Certainly in modern times there has developed a false sense of security that all is well with science and with religion — merely because they have been kept in separate compartments. I would endorse Professor Schilling's remarks that "There still exists serious tension between them" and that "at the level of theoretical interpretation . . . tension is almost inevitable." I would not relax this tension by his claim that "the occasions for misunderstanding, apparent contradiction and conflict between science and religion are decreasing." "Many of the old issues and complexities are disappearing" — but not to the extent of minimizing the new ones continually taking their place. I cannot completely agree either that there is a "growing conviction among both scientists and theologians that conceptual knowledge as well as experience must be unitary." Such generalized judgments about people are always difficult to validate. In the first place, it is difficult to design an acceptable "sample" of any population. Secondly, one usually listens primarily to outstanding instances and then remembers mostly those favorable to one's own views. What does the average scientist or average theologian think? A strong case, I suppose, might actually be presented for a growing group of people in the world who are antagonistic to religion in any form. After all Professor Schilling is speaking for himself — or at most for a particular philosophical attitude which he represents. There are many scientists who would honestly differ with the author — and with me.

"Science and religion are experientially complementary" is the thesis of Professor Schilling. I cannot be quite certain I understand the peculiar meaning of each of his words: science, religion, complementary. Nevertheless the sentence as a whole seems to make sense to me. Later, it is true, he defines the word complementary to signify that "they interpenetrate and interact existentially in their concerns, interests, and attitudes." Here again I must confess an uneasiness about the word "existential" which is used so frequently nowadays as a meaningless stamp of fashionable approval. Do I note a contrary tendency to ignore the subject qua subject, to disregard the metaphysical which lurks in every subject's empiricism, to neglect the identifiable psychological? I seem to need clarification about complementarity also when I read "in the rich and inclusive full life they [religion, art, science] are inseparable." Perhaps it is only in the expression of the idea that I would differ. I heartily agree that both "science and religion are rooted in the same experiences." Out of these very experiences indeed certain aspects are noted; upon these in turn theoretical constructs are founded. In view of the common source some overlapping of the resultant structures would not at all be surprising. At the same time one would not necessarily expect these structures to be identical or even compatible. The problem of cur-

rent conflict therefore would inevitably be in the overlapping region which would continually change; the apparent complementarity on the other hand would be in those regions that did not overlap.[1] Whereas I would admit that "a complete rational system or synthesis of science and religion is impossible," I would never assent "that the search for it should be abandoned." It is only in the persistent seeking, I believe, that we can hope to find a continuous reconciling of differences. The obstacles that Professor Schilling lists to formal, conceptual complementarity are worthy of emphasis; particularly his concern about a scientist's humility with respect to the extrapolation of his methods and the universality of his results. In this connection I must note that my own interpretation of Galileo's attitude to the relationship of Kepler and Copernicus would be somewhat different from that stated by Professor Schilling.

I would also agree in general with his new outlook in science, but with less stress perhaps upon the statement that we are "becoming more holistically minded and less likely to forget the whole as we study the parts." May not this be another of these generalizations that may be characteristic of a particular sub-discipline as cultivated by a certain group of people but not necessarily true universally? In view of the fact that this article is definitely for popular consumption it is not surprising that one finds oneself wondering at times as to the precise meaning of words like science and religion, reality and being, truth and knowledge, goodness and beauty, life and the existential, the divine and the holy, etc. He encourages us, to be sure, to think in terms of common-sense meanings. On the other hand science has often made its greatest progress in challenging the common sense of today which was the uncommon science of yesterday. Despite Professor Schilling's rhetorical question, viz., whether anyone would deny the certitude of the sunset's beauty in comparison with that of empirical observations of the radiation, I do not find self-evident the great distinction he would make. Are there not individuals who appreciate the beauty of music but who nevertheless do not understand the theoretical structure of its make-up and vice versa? Likewise the definition of the holy as "that in our environment to which men have responded down through the ages in worship and prayer, faith, reverence, whole commitment" fails to give this concept the precise distinctiveness that I would like.

On the whole, I repeat, I found the article illuminating. Of course, you and I might have expressed matters differently. I, for one, would have stressed more the creativity of both science and of theology; I would have underlined the greater difficulty of communication in theology than in science; and I would have stressed more the need of faith in both. I would probably not have been so

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[1] My own view has been expressed in more detail in "Scientist and Theologian?", *Jour. of Washington Academy of Sciences*, 48, 146-152 (1958).

clever as to select the Whitehead quotation with which he began and ended his article. I would however have insisted that the relation (including the problem and the complementarity) is as much personal as social; and the decision, as much individual as political. Professor Schilling's most notable contribution indeed is the declaration of his own personal faith — a comfort to those who believe — a challenge to those who do not believe.

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II

Dean Schilling has raised the interesting question as to whether and to what extent religion and science may be regarded as complementary modes of description of a unitary reality. It is my opinion that while complementarities undoubtedly exist at all levels of epistemology, religion in the Judaeo-Christian tradition, although itself containing such complementarities, cannot be identified with one of them. Rather it has a transcending and synthesizing function in the quest for knowledge of both the divine and the secular. In order to clarify the issue a brief analysis of the meaning and nature of complementarity will be given.

The modern idea of complementarity stems from the impossibility of complete detachment of subject and object. Knowledge of the world or of some segment of it is obtainable only by being in the world. The inquiring subject is either naturally involved with the object of inquiry or to gain information must interact with it, and this involvement or interaction necessarily implies some distortion in the picture of the object thus obtained. For the purpose of logical analysis an artificial separation of subject and object is made. On precisely how this separation is effected depends the consequent picture. Pairs of complementary descriptions may emerge qualitatively disparate and often contradictory and antagonistic. Because of the tentative and approximate character of such separations, no one view, although it may reveal some elements of truth, can claim any absolute finality. Indeed the unwarranted ascription of finality to any one mode necessarily obscures or negates the complementary mode and so seriously distorts reality.

The principle of complementarity is thus a principle of impotence: it is impossible to obtain a completely objective view of reality. It is an astonishing fact that principles of impotence have had great heuristic value in physics and mathematics. Other examples are the impossibility of discerning absolute motion (relativity) and the impossibility of constructing a perpetual motion machine (ther-

modynamics). It remains to be seen whether such principles can be equally valuable in other fields of knowledge.

Complementarity is manifest at all levels of knowledge. Even in the abstractions of mathematics the impossibility of complete objectivity has led to the frustrating theorems of K. Gödel who has shown that logical systems are incomplete in the sense that they contain propositions undecidable within the confines of the system. In particular no logical system can contain a proof of its own internal consistency. In order to validate the system it must be transcended: an appeal must be made to a higher logic which however is in turn not self-validating. Thus one is led to an infinite regression strikingly analogous to the regressions of the ego experienced in conscious thought which will be mentioned later.

It would appear that in physics the best opportunity for detachment exists. The subject in this case is originally satisfactorily detached but to obtain knowledge must employ an apparatus or probe which interacts with the physical object. It might seem possible in principle at least, by making the probe ever finer and more delicate, to approach with negligible distortion the ideal separation of subject and object. This hope has been frustrated by the discovery of the discrete universal quantum of action. In consequence attempts to analyze physical behavior at the atomic level in terms of the classical concepts of particle, wave, position, velocity etc. have led to such paradoxes as wave-particle duality and the indeterminacy principle. Although a mathematical synthesis has been obtained in the quantum mechanics of non-commuting observables which yields consistent and non-contradictory results, it still is necessary for the physicist to think in terms of pictures and models drawn from every-day life: i.e., the classical concepts. He has learned that such pictures, although valuable aids to thought, must be used with caution as they do not give a trustworthy representation of reality and the sharper one such picture becomes, the more obscure becomes the complementary aspect.

It was the great Danish physicist, Niels Bohr, who introduced the notion of complementarity into physics. He has applied it also to other branches of science: biology and psychology as well as to cultural and sociological problems. He has pointed out as has Dean Schilling the complementary character of science and art. His first thoughts of complementarity, antedating the application to physics, were in connection with the moral antinomies, e.g., love versus justice and moral condemnation versus causal explanation of immoral behavior.

Bohr has suggested that in biology one meets a new phenomenon, life, which may stand in complementary relation to an analysis of a biological specimen in terms of its molecular constitution. A too earnest attempt to interpret life in terms of structure may lead to the death of the organism and so be self-defeating.

The involvement of subject and object becomes more intense as one enters the field of human relations and psychology. If the object is a person, he may be viewed alternatively as an association of molecules, as a biological specimen, as a behavioristic gestalt, or as Thou. Too great an emphasis on one or another of these aspects may obscure the insights obtainable from the remainder. On the other hand the subject, another person (or even the same in introspection), finds himself affected by the need for artificial detachment. Because of the involvement of subject-object, a new subject is projected able to view a new object, the former subject-object. The familiar regression of the ego, so much a feature of conscious life, is thus seen to be a consequent of complementarity. Corresponding regressions may occur also in the object viewed as Thou who manifests a slippery character always evading complete description and revealing himself in new and unexpected guises. One is faced with the impression of inexhaustible and unsearchable depths.

In deciding whether science and religion are properly to be regarded as complementary descriptions of reality one must scrutinize their methodologies and experiences to see whether one and the same reality is being analyzed from disjointed perspectives. The answer obtained will depend on what is meant by religion. If a consistent and thorough-going pantheism is maintained, a good case can be made for Dean Schilling's thesis. On the other hand an analysis of religious experiences in the Judaeo-Christian tradition would seem to lead to a different answer.

The universal religious experience in the Judaeo-Christian tradition is the experience of being grasped by a power beyond ourselves and beyond the world, although at the same time closer to us than we are to ourselves. In the grip of this power all pretence to objectivity is dropped. Indeed the subject-object relation is inverted and we find ourselves as the ideal object: completely objectified and without the ability to slip away. This disconcerting state of affairs would be intolerable were it not for the accompanying gift of grace which, if we accept it, restores our humanity by making us as children and providing an unexpected access to the divine by opening to us the gates of the Kingdom. All of the experiences noted by Schilling — the burning bush, the angelus, the whirlwind — are of this kind. They can hardly be understood as the response of reality to the stimulus of religious inquiry. In the face of such experiences it is impossible to regard the Judaeo-Christian religion as merely a complementary mode of the description of reality. The God thus encountered, the God of Abraham, Isaac, and Jacob, is with us in all our searches for truth: correcting, conjoining, synthesizing, clarifying, and empowering.

I believe that Schilling is right in thinking of the artistic view as complementary to the scientific view but wrong in supposing that religious knowledge concerns the same reality as scientific knowledge. Science deals with crea-

tion: space and time and the world of nature conditioned by space and time. Religion deals first of all with God who created space and time and is not conditioned by them. Science is possible because the world of nature can be partially transcended and objectified. Religion is possible because of the Grace of God who cannot be transcended and objectified, even partially. This is not to say that God is not immanent as well as transcendent, but his presence in the world conditions the world, not himself. In a crude analogy he shines by his own light, the world by his reflected light. To be sure by this reflected light we may learn something of him; natural theology is not devoid of significance and can perhaps be understood as standing in complementary relation to biblical theology.

Religious knowledge, although obtained through grace rather than by observing responses of the religious object, is in fact replete with complementarities because it is received and interpreted by the finite and conditioned mind. Indeed all the great heresies that have afflicted the Church can be understood as the result of undue emphasis on one facet of religious insight with consequent obscuration of complementary insights. The Church however has always maintained that the true synthesis is discernable although it may involve the unblushing acceptance of paradoxes such as the wholly human, wholly divine nature of Christ. It is a striking fact that this recognition of the complementary nature of truth should be primarily a religious insight, used by the Church throughout her history and only recently gained by philosophical thought. This fact points to the proper role of religion in epistemology as transcending, synthesizing, mediating, and conciliating. The power to play this role is derived negatively from the First Commandment, the requirement to reject as idolatries all ideologies based on partial and incomplete insights, and positively from revelation of the Way.

While the necessity for complementarity derives from the involvement of man in the world, his finitude and incapacity for absolute transcendence, the ascription of finality to resultant one-sided views derives from his sinful tendencies, his separation from God. The cure then is reconciliation, already effected for the Christian. In the words of the scientist-theologian Blaise Pascal: "En Jésus-Christ toutes les contradictions sont accordées."

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III

May I begin by saying how very happy I am, as one working in the field of historical theology, to find a professor in the field of physics writing so ably and with so much concern in the basic problem of our time. He is quite right in

introducing his paper with the quotation from Professor Whitehead. In the importance of this question, the late Dean Inge agreed with Professor Whitehead. In my student days, I was much under the influence of Dean Inge, as well as under that of the great German-English-American school of liberal theologians and historians. Dean Inge once said that "Science has come with her winnowing fan, and she will not cease until she has purged religion of all her superstitions." This I will always accept, but we must define superstition. According to Webster, it is "An excessive reverence for, or fear of, that which is unknown or mysterious . . . A religious belief regarded as irrational and misleading." I am still of the opinion that religion must permit science to do this. Dean Inge also said that "Unless Christian theology makes an alliance with Platonic philosophy, it is doomed to extinction at the hands of science." These comments by the great Dean of St. Paul's illustrate full well Professor Schilling's starting point in Professor Whitehead's quotation.

These two concepts of Dean Inge; namely, the critical faculty of scientific knowledge and the rational defense of an idealistic philosophy, have been central in my thought for more than a quarter of a century. They have led me to the problem of knowledge which I think is the heart of the matter and to which I shall return later in this comment.

With a great deal of Professor Schilling's paper I am in hearty sympathy, and there is no point in taking up space reinforcing these agreements. Rather, it seems to me that, for the good of an intellectual discussion, I might well point out one or two serious problems yet remaining. As a very subordinate criticism, may I say that the essay indicates a little too much presuppositional enthusiasm. This is indicated by a too constant use of such words, prejudicial to rational thought, as "meaningful," "convincing," "compelling," impressing itself," "compulsion." It would be better to let the ideas do their own work than to have Professor Schilling always tell us they have the qualities conveyed by this vocabulary.

The five major points involved in the interaction between science and religion are well discussed, but even in this my deepest concern seems not quite to be cared for satisfactorily. This concern is that Professor Schilling does not define science adequately. Science is an intellectual methodology, not a procedural form. Science is an unreserved pursuit of knowledge, not a previously defined path for that pursuit. In any definition of "science" the situations indicated by the words, "control" or "observe" and "predictability," must be involved. Now I submit that there is no area of human experience in which these operations are truly excluded. Some theologians have said that science deals with objects, and since God is not an object it follows that he isn't a proper subject of science. But is this so? The knowledge of God, that is, the experience of God which men have, *is* an object, and science *can* study it. If one wishes to narrow science to a subdivision of the human intellectual life, he must then use adjectives such as "physical sciences" or "natural sciences."

Deeper than this is my question as to whether or not the essay states the fundamental issue. "Does the universe include any reality other than that recognized by the sciences" is the way Dr. Schilling states the fundamental issue. May I suggest that it should be stated in the form of the nature of knowledge, as for example "Is not all knowledge known to men of the same nature and known by the same means?" This is to say, is it not necessary that we now give up the word "revelation" entirely or so define it as to permit the attitude and methodology of science to provide the approach to the propositions once considered as "revealed"? Let us not weakly escape this question by a quibble over words. By whatever name or method we describe it, "revelation" is a division of knowledge.

As Professor Schilling nears his real conclusions, he involves concepts and attitudes very welcome to me in the history of religion. I refer to his use of "relativity" and "experience." As theology attempts to readjust to the accurate knowledge and vast vision which man now has of his environment, she must increasingly use " relativity" as the key to her thought system and "experience of mankind" as her sole criterion.

Welcoming as I do Professor Schilling's able essay, I invite him to continue his forward movement as indicated in the section called "Prospect" and to work out for us a doctrine of knowledge which would bring to end the only important cleavage between science and religion. To accomplish this, he must be willing to submit what he calls "The communal experience of the Church" to as thoroughgoing a critique as he would any other area of human knowledge. This reference to the Church in history is the weakest point of the essay, and yet it recognizes the debt we all owe to historically continuous cultural patterns. The fatal moment occurs when a thinker accepts on "emotional" and "inner-security" grounds the "communal inheritance" as if it were true. It is simply not true "that here in the communal experience of the Church we do have a solid permanent body of constant experiential data and not only the variable kind." Any church historian worth the honor of his vocation knows full well that every experience and every doctrine is subject to, as it is product of, the "variable." Here, as elsewhere, the critical mind reigns master over the data. Only that is constant in our religious inheritance which has to do with attitudes and acceptances, and these for a free man are as free as his evolving and developing knowledge.

We stand at the beginning of great advances as we come to understand that knowledge is of one seamless framework and cannot as such be appropriated by one or another of the subdivisions of human experience. The leaders of the Christian community need in the mid-twentieth century, more than at any time in the past because the issues are vital and the environment so vast, to accept history and science as correctives to doctrine. Otherwise there will be no reconciliation and little co-operation.

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IV

Professor Schilling begins with the full recognition — too often ignored — of the fact that the alleged conflict between "science" and "religion" is by no means over. Moreover he correctly points out that the important issues today among thinking people are not so much hackneyed problems such as whether miracles do (or do not) occur but rather whether there is not a much more basic incompatability between the scientific and religious attitude towards (and therefore understanding of) what is given in human experience. He proceeds to deal with this issue by considering whether there is any "kind" of knowledge other than that which can be obtained by scientific means. His answer to this query is that there is, and he proceeds to defend his thesis by providing his readers with a moving analysis of the differing meanings that we can give to the phrase "the radiance of the sunset." Science, he maintains, somehow deals with its truth whilst art deals with its beauty whereas religion deals with its holiness. At this point Professor Schilling reminds one very much of the famous New Testament scholar, B. H. Streeter, who a generation ago in his book, *Reality*, argued that science deals with the "representation" of truth whereas art "suggests" truth.

But does not Professor Schilling leave himself open to the criticism which Streeter never answered? How does Professor Schilling or Canon Streeter know (since "it" can be known in these two or more different ways) that there is *one* sunset? The answer to this question is not an easy one on any theory of human existence. Yet man seems inescapably tied to the notion that the word "knowledge" has no meaningful plural; and so whether we like it or not Professor Schilling cannot answer this question by sticking to his intention to limit himself to what he calls empirical grounds, for the issue involved is a metaphysical question (pages 377 and 378).

The same issue turns up in another connection when Professor Schilling remarks that "science, art, and religion have differnt purposes." There is surely need to go further than he does, for must we not profess or ask the question: "In terms of what set of categories can science, art, and religion be understood as existing in the same world?" In other words it looks as though Professor Schilling is being driven to the conclusion that there is something more basic than "religion" and that it is this something which gives final meaning to these three separate activities. Yet is not this a contradiction in terms? It is difficult not to conclude that this predicament arises for Professor Schilling simply because for him somehow "religion," "science," and "art" are all at the same level. Let me add that Professor Schilling has not failed to see this issue for at another point in his exposition he recognizes that although religion "represents only one kind of experience" it is also true to say that "religion spans all of life." But has he done full justice to this insight?

In the second half of this paper Professor Schilling makes a still more valuable contribution to the current discussion which put us all into his debt. I do not know of any writer on either side of the Atlantic who sees more clearly and who has

argued more persuasively for a full recognition of the meaning of community in science by reminding us that the scientific movement includes all the countless men and women who have toiled unsung as well as the Newtons, the Pasteurs, and the Plancks. I hope that at a later date Professor Schilling will expand into the paragraphs of an article the hints at this point he tantalizingly gives us in this paper.

One last point: would not Professor Schilling have enormously strengthened his whole case by analyzing the significance of the fact that the whole scientific movement itself rests upon an act of faith in that the strength of scientific knowledge itself is what it is because the entire body of scientific knowledge rests upon a set of presuppositions which of themselves cannot be proved. It is a little embarrassing to make this point in concluding my comments on Dean Schilling's paper since he himself has just published an able analysis of what is involved here in his *George Stewart Memorial Lecture* given at the University of Iowa under the title "Concerning The Nature of Science and Religion; A study of presuppositions." To all readers of Dr. Schilling's article in these pages this published lecture is urgently recommended.

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Books and Publications

Christian Faith and Science

A Review Article[1]

Can one stress too much the importance of this subject at the present time? I do not think so — least of all to Christians. Science is creating a new civilization around us. Scientific skills are becoming the basis of economic life; scientific techniques are ubiquitous, transforming both the factory and the home. And not merely the higher standards of living, the greater opportunities, or the added powers of modern technology affect us. It is even more the subtle changes in our ways of thinking which makes science a vital subject today.

Because of the prestige which science now possesses and because of its undeniable ability to achieve results, science is making a particular impact upon us all: the scientific way of looking at things is increasingly being thought of as the ideal way to understand the world as well as to control it. The increasing respect being given to scientific ways of understanding things affects both professional and layman, scientist and non-scientist, Christian and non-Christian. To this kind of understanding, the faith professed by Christians often seems old-fashioned, and the man of today with his technical know-how does not naturally incline to follow the authority of a Gospel from a pre-scientific era. Besides this our whole educational system, as Dr. Pollard has pointed out in a recent article, is geared to the consolidation of this trust in the scientific approach and in man's ability to run his own universe and his own affairs by his own knowledge. In this situation it is we Christians who are challenged. We have only dimly realized what has been happening. But we must try to understand it and to act accordingly. There is a lot of hard thinking to be done. These books represent a part of it.

What then is science?

And how does it affect Christians or the Church? The movement which we now call modern science started, speaking very roughly, about four centuries ago. It built upon foundations laid by the Greeks; it was moulded by practical skills elaborated over generations by the craftsmen of the Middle Ages; it employed insights partly borrowed from philosophers, partly stumbled upon by eccentric experimenters; it was motivated partly by the attraction of making nature more useful to man, and partly by a sheer curiosity, sometimes fervently religious, to explore the secrets of the universe. It began cradled, as it were, within the framework of Christendom; and its pioneers were frequently teachers in the Christian Church; nevertheless, as it developed, it proved very disturbing. Among other characteristics the scientific movement claimed to be subservient to no auth-

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ority but that of experiment. Gradually it began to produce results which were in contradiction to long-established teachings of the Church — on the place of the earth in the solar system, on the age of the earth, on the origin of species, on the nature of the soul. Thus by a succession of clashes, including the pitched-battle debates of Darwinian times, we come to the present day and to the slogan that "science disproves the Bible."

It would seem to many people — and it is loudly asserted by some — that science has won every bit of this contest: that religion has done nothing but give way and yield ground. The fierce antagonisms of the nineteenth century have given place now to a relatively quiet truce. Is this because the Church has now learned its lesson, *viz.*, to stick to purely spiritual affairs and not to interfere with the proper business of science? So say the secularists; and, let us remember, they are the great majority today. Or is it because science itself has become less arrogant and consequently more tolerant as it itself encountered mysteries in nature? Or are Christians just too cowardly now? Probably there is truth on all sides. Anyhow, we do well to ask, "Why did the conflict occur?" and "Need this conflict continue?" or indeed "Need the conflict have occurred at all?" Recent writers on this question may be contrasted among themselves as to the position they take up on this issue. Before commenting on the books by Smethurst and Mascall, which are the main target of this review, I shall consider first several authors who, broadly speaking, have emphasized the brighter aspects and second some who have examined the difficulties more closely.

Raven and Coulson: Science is revealing God's handiwork

The most extreme on what may be called the optimistic side is Canon Charles E. Raven. He believes the quarrels need never have taken place. In his Gifford lectures, *Natural Religion and Christian Theology,* Part I (Cambridge University Press, 1933), he gives his own detailed and very scholarly account of the growth of science, rejecting completely the idea that science and religion are incompatible and arguing that, with the further development today of biological theory, science is even now coming to an appreciation of the mysteries and unity of nature as religious in essence as any Christian could wish. Canon Raven has restated these views with delightful brevity and made them widely available in his *Christianity and Science,* No. 4 of the "World Christian Books" (Association Press, 1955).

Rather similar in tone is the view expressed by Professor C. A. Coulson in *Science and Christian Belief* (University of North Carolina Press, 1955) and in his Riddell Memorial Lectures, *Christianity in an Age of Science* (Oxford University Press, 1953). Truth is one, he insists; therefore the scientist too is bringing us knowledge of God or at least of his works and therefore of his character. Christians must stop fighting a defensive battle, attempting to prove God's existence by pointing to the yet-unsolved mysteries of life. That god is a "god of the gaps": a god whose territory is diminishing with every advance of science: not

the Christian God but an idol to be adjured. Science and religion need not quarrel but should respect and aid each other like good neighbors. They cannot in the nature of things, Coulson argues, be contradictory; therefore they are complementary, he concludes, rather like the wave and particle theories of light. Let Christians then rejoice, for science is showing us something of God that none of his prophets have or could have conveyed to us.

There is truth in this of course. Science and faith should ideally be in partnership. The optimistic mood is to be found too in some recent American writers on the subject, notably James B. Conant, e.g., in *Modern Science and Modern Man* (Columbia University Press, 1952), and in E. L. Long's *Science and Christian Faith* (Haddam House, 1950). The latter book, subtitled, "A Study in Partnership", is especially perspicacious, for here the optimism — the vision of the ideal — is tempered by caution. After giving a history of the rise of science and its alienation from religion, Long examines in careful detail some of the dangers of uncritical capitulation to the current scientific world-view. While science, as a tool for the acquisition of knowledge, is unsurpassed, it has to be borne in mind that ultimacy belongs to religion, not to science, since "interpretation is more ultimate than fact" (i.e., than scientific observations) and "commitment is more ultimate than skill." Thus for true partnership scientific skill must be applied in commitment to Christ. This is an excellent book in the reviewer's opinion; although its small size and its free use of clichés make it appear unscholarly, it is of clear insight and relevance to the modern situation.

Another author who surveys and interprets the history of the growth of science in terms of its impact on Christian faith is Dr. Mary Hesse. In her thoughtful book, *Science and the Human Imagination* (SCM Press, 1954), she shows how the creative aspects of physical science have been very closely related to religious insight or governed by religious attitudes. Partnership is in this sense natural. But she warns us that "there is no satisfying synthesis of science and Christianity this side of the Kingdom of God." This book should be read after Herbert Butterfield's excellent book, *Origin of Modern Science* (Bell, 1951. A new edition has just been published).

Not all recent writers (even in the United States!) have presented the relation between science and religion as a happy one. A remarkable and provocative book by W. T. Stace, *Religion and the Modern Mind* (Macmillan, 1953), analyses the disillusionment of modern man and traces this directly to the scientific picture of a mechanical world. There has certainly been a conflict, Stace makes it very clear, and it continues still at a level deeper than mere questions of fact. He devotes successive chapters to the consequences of the rise of science for morals, for religion, and for philosophy. Stace writes as a religious man; to him "religious feeling" — and he is unwilling to be more specific than that — is an essen-

tial, irreplaceable element for human life despite the scorn of an agnostic scientific age. But if Stace sees such difficulties from purely religious grounds, will a Christian find these problems worse from the standpoint of specifically Christian belief? "Not at all", Coulson would say; and "Quite the opposite", Raven would also insist; for the Christian has eyes to see that it is God who is in science and behind science showing us more of himself. "Rather worse" however would be the reply from Whitehouse, since Christian belief is more vulnerable than religious feeling. For myself, though I know and feel what Coulson means, I am inclined to agree more with Whitehouse at this point. I wish now to consider in detail his most incisive, though not very lucid book, which delves deeply and very frankly into this thorny problem, doing so precisely from a Christian point of view.

Whitehouse: "to the scientific attitude . . . Christian faith seems faintly disreputable".

Whitehouse in *Faith and the Scientific Attitude* (Oliver & Boyd, 1952), like all the authors considered so far, is well aware of the relatedness of scientific work and Christian principles; and he too is keenly concerned that Christians should have a right appreciation of what science is doing and should give it the respect it is due. However he is most of all concerned about certain essential differences which he sees in the basic approach to experience (presuppositions) of the scientist, as compared with the basic outlook of the religious man (and more particularly of the Christian). There have been others who, for the sake of amicable relations or because of specialized interests, have tended to belittle or even to pass over these fundamental contrasts. However, Whitehouse feels that it is in the interests of both parties that the differences be faced fairly and squarely. It is not unfriendliness but mutual concern that should drive us to scrutinize with all possible frankness the divergencies of viewpoint which exist. Furthermore he does not want to discuss vague generalities, "science and religion . . .", but chooses to focus attention quite specifically on the clash of scientific thinking with the Christian viewpoint: with "Christian faith professed in its full integrity," as he puts it. Now, what are these divergencies, these fundamental contrasts?

In an important section (Ch. 3, Pt. II) Whitehouse lists five features which he feels to be representative of the framework within which Christian thought must move — features of the Christian world-view which are "so alien to a mind of scientific cast that it is hardly possible to entertain them." For example there is the idea, essential to Christian faith (though not a prerogative of Christian faith), that everything in the universe happens through God's activity. The scientist simply has no evidence of such a thing as this; he characteristically dislikes making assumptions without evidence and is therefore inclined to be sceptical. He need not be sceptical, logically; but in practice he is inclined to be so. Another example is the belief, also integral to Christian faith, that some Purpose underlies all events. This too, because it cannot be checked and does not affect experiments,

is a conception unpalatable to the scientific mind; it is given therefore no attention by a scientifically thinking person. Still another example, impinging now upon the very hub of Christian doctrine, is the belief on the part of the Christian that in certain quite particular events (the Jews of history) the meaning and the purpose underlying the universe are disclosed. "It is perfectly clear," remarks Whitehouse, "that a scientist will be averse to such a committal, with all its scandal of particularity." And the whole notion of revelation, which is so central in the Christian understanding, is at variance with the scientific mood. A personal God seeks fellowship with his creatures; knowledge of him is our only real fulfillment; sin clouds our perception and thwarts our response; all this is foreign to the temper of a scientific intellect to whom the way to all knowledge is open by the intelligent application of exact thinking and controlled experiment.

These are not the only aspects of Christian faith to which Whitehouse directs attention in this way. A large part of his book consists of an exposition of the Trinity: God the Father (including the Creator), God the Son (including the mystery of the Incarnation), and God the Holy Spirit; at every point he contrasts scientific outlook with biblical teaching. His summary of the essential elements of scientific thinking (of which he lists six) is in chapter 8, part II.

It must be understood that, by asserting that a person of scientific attitude is averse to Christian faith, Whitehouse is not claiming that science as such refutes Christian faith or undermines it; nor is he saying that the people who pursue science are deliberately antagonistic to Christian faith, far less that they have scientific grounds for opposing it. What Whitehouse is emphasizing is that there is such a thing as the scientific attitude, and that this, rather than scientific facts or results or arguments, is of immense significance. The scientific attitude "engenders a cast of mind", he insists, and this, for all its nobility, includes a subtle predisposition away from such features of Christian belief as he exemplifies. "The scientific attitude breeds a skepticism, . . . or perhaps an indifference bordering on repudiation."

It is a pity that, by a wealth of really unnecessary biblicisms, Whitehouse has allowed his work to take a form unpalatable to the average secular reader — whom nevertheless he apparently wishes to address! The book is also rendered difficult to read by its winding, branching style; and the rather English habit of elaborately cautious avoidance of over-statement does not make reading any easier. Thus, his conclusion is stated characteristically: "There are, I think, factors to be reckoned with in Church thinking which, make it impossible to reduce its difference from scientific thinking beyond a certain point."

Against Whitehouse's thesis as a whole, the criticism may fairly be made that he has been too negative and has given insufficient attention to a constructive answer, despite his avowed conviction that "a scienific attitude is no bar to the

life of faith." It is useful to contrast the more constructive approach that is to be found in the work of Karl Heim, Professor of Theology at Tübingen. Karl Heim's two books, *Christian Faith and Natural Science* and *The Transformation of the Scientific World View* (Harper, 1953), contain a profoundly imaginative and stimulating analysis from the point of view of a deeply thinking philosopher of what science is really doing and how we Christians should speak to the scientific man. This work has been reviewed already in *The Student World* (by Mary Hesse, 1953, p. 275) and in closed detail in *The Christian Scholar* (by Barbour, 1956, p. 229), so I shall not discuss it further here except for two remarks. First, as to his approach (and "optimism"), Heim is not unlike Raven in that he believes that recent developments within science itself have been such as to make the scientist more open to the postulates of Christianity now than, say, a generation ago. Secondly, as to his treatment of the subject, Heim is existentialist — quite unlike any of the books so far mentioned in this review. Persons, personal encounter, personal knowledge and decision are his basic categories.

I turn now to the consideration of two quite recent books, published at almost the same time. Both authors are theologians of the Church of England with personal experience of training in a branch of science (Smethurst in chemistry, Mascall in mathematics). Though covering virtually the same subject matter, the books do not duplicate one another but in fact are surprisingly different.

Smethurst: *" . . . science and Christianity need never be in hostility"*

A. F. Smethurst, feeling very rightly that there is always value in a general survey of a subject, perhaps especially by one who is not expert in all the topics referred to, has attempted to draw a comprehensive picture of the relationship between science and Christian faith. His book, *Modern Science and Christian Beliefs* (Abingdon, 1955), does not claim to go into very great depth but does try to be inclusive and systematic in its coverage. Accordingly a discussion of problems occupies about two-thirds of the book, and these are classified and taken in order. They commence with those connected with the physical sciences (e.g., cosmology); some problems in biology follow (e.g., evolution); then several problems related to the scientific study of the human body and mind (e.g., in psychology); lastly there is a large group of problems arising out of Christian doctrine (e.g., miracles). This extensive march over many battlefields has the great merit of giving the reader a bird's-eye view: a sort of over-all perspective which is exhilarating. In the course of the survey Christian beliefs are repeatedly found to be quite simply enriched by the advent of scientific knowledge. The principle is exemplified by the belief in God as Creator: our conception of God is only all the richer for our knowledge now of how vast the universe we live in is and indeed how very possible it is that there may be other races of intelligent creatures elsewhere in the cosmos. It is valuable here to contrast Whitehouse who remarks (p. 118), "There is a characteristic Christian doctrine of God the Creator. It is futile to try to bring this concept into

line, so far as may be, with what science lets us believe about God. It will be modified out of all recognition." In Smethurst's hands however each impact of science is either welcomed as enobling or else it is rebuffed with superlative confidence and complete absence of anxiety. An example of the latter is afforded by his treatment of the Virgin Birth: Parthenogenesis is an unlikely thing, it is admitted, but not scientifically impossible, for after all . . . an egg might begin to divide under the stimulus of some radiation; and the historical evidence is good, so there is really no reason even for the scientist to balk at this doctrine.

Personally I doubt whether a scientist would be so easily satisfied. But the clue to Smethurst's good cheer is to be found in Part I, which precedes the survey. In these chapters, headed "General Questions," the presuppositions of science are outlined — for example, the assumption of the orderliness of nature, its intelligibility, etc. "Once the presuppositions of science are recognized, there is no danger . . . ," it is stated. For these are theological in character, and science is indebted to Christianity for its use of these ideas, and so science, being thereby founded at rock-bottom on Christian principles, cannot conceivably conflict with Christian belief. Now, that presuppositions are theological in essence, I heartily agree; and that the scientfic movement, as a matter of historical fact, gained much of its attitude to nature from concepts of Christianity, I am prepared to accept. (Hesse's book develops this thesis in some detail; Mascall's book [see below] is doubtful however.) But to claim that science could not exist apart from Christian justification for these attitudes appears to me both untrue and unnecessarily arrogent. Yet the assertion is dogmatic: "Only the full Catholic Christian faith can supply both the necessary theological and philosophical beliefs as to the nature of the universe which are required to justify studying it by the scientific method, and also the impulse and inspiration which will impel men to undertake this study" (p. 20). Can such a thing really be maintained? Presuppositions surely are just those very attitudes which are *not* justified by resort to deeper faiths since they *are* the deepest; but they become self-justified through use, and I would suggest this is virtually their sole justification in the mind of any representative scientific thinker today. Are all scientists in the U.S.S.R. Christian because scientific? As the Hindus, Moslems, or Buddhists in India or Japan build up their scientific and technological institutes, do they at the same time exchange their religion for Christianity? I do not think so. On the contrary I feel that one of the most vitally important of our tasks today, as Christians, is precisely to see that science, for all its Christian origin and its Christian associations and its Christian potentialities, is not *qua* science necessarily thereby Christian in essence or in structure now. No doubt it could be; perhaps it should be. But we must not confuse our wishful thinking with hard facts.

Mascall: " . . . it is possible . . . to engage in conversation"

E. L. Mascall, a philosopher-theologian in Oxford, writes on virtually the same title, but with rather more soberness. *Christian Theology and Natural Science*

(Ronald Press, 1956) is a scholarly work of great sincerity. Mascall does not range over the totality of possible problems but selects about six which are then pursued intensively. Consequently his book has not the grandeur of Smethurst's survey. However his first chapter, on the contacts between science and theology, sets the scene and provides the context for the detailed studies which follow.

"It is possible for theologians and scientists to engage in intelligent, good-humoured, and fruitful conversation." Such is the basic belief which inspires this work. There is no pretence that to every question an answer can be laid down nor that spurious answers can always be shot. Indeed mutual shooting is the antithesis of Mascall's conception of the relationship between science and theology: mutual help is what is required. Hence the scholarly, friendly, and profusely annotated discussions which he conducts on body and soul, on Creation, on indeterminacy, and other similarly important topics.

The theological position from which Mascall writes is that of neo-Thomism. His handling of the body-mind problem is therefore very different from that of Smethurst who, acknowledging the far-reaching explanatory power of present-day physiological knowledge, concludes that the word "soul" should now be dropped and replaced by "self" which, he adds, is more biblical anyway. Mascall in contrast cannote renounce a conviction in the soul: "the great tradition of Christian theology . . . has steadily taught that a human being is a highly mysterious creature, composed of body and soul . . ." (p. 251). He is well aware that a great current of contemporary philosophy is dead against this to the point of ridicule; nevertheless he considers and defends what he feels to be a necessary belief with skill and with dignity. Even if we disagree with his position here — and there are many who will denounce the very questions he raises — we must be grateful for his having written these passages. For the mind-body problem is not solved yet, neither by neurological behaviorism, including the hard-hitting analogies with the behavior of artifacts, nor by the complementarity principle which would have us believe that the problem never really existed. The Christian is irrevocably committed to a concept of God as Sovereign, Lord of both man and the universe (this is what creation, speaking theologically, involves); therefore there must be some sense in which our Christian affirmation, "God is a Spirit," is understood to mean that God is distinct from matter and things. But if, by appeal to complementarity, we say that man *is* the material of which he is formed (viewed as a person of course), then what shall we say of the unique relationship that man has, we believe, with God who is not material? Or if we apply complementarity to the universe, do we slip thereby into pantheism? Perhaps there are answers to these questions, but they are neither easy nor simple; and the whole nexus of problems in this area alone is in reality profoundly disturbing — and not merely for Christian thinkers.

The non-Thomist Christian reader will not find himself out of sympathy with Mascall's other chapters but will find them illuminating and equally provocative.

The care with which important yet subtle philosophical distinctions are manipulated, or metaphysical issues are discerned and scrutinized, makes the study of this book intellectually invigorating. It abundantly fulfills its declared objective: to serve as part of a conservation and to stimulate thought. Let us hope that it will be read and studied as it deserves and that other contributions to this conversation will ensue.

Both Smethurst's and Mascall's books are well documented — especially the latter — with copious references for the student who wishes to delve further into any particular aspect. Their bibliographies are rather different, as might be expected from what has been said of their approach. This illustrates the way in which the books complement rather than duplicate one another. A feature which renders Smethurst's book of additional value is the inclusion of four appendices on logical positivism, dialectical materialism, existentialism, and "Rudolf Bultmann and Karl Heim," each remarkably lucid. In Mascall's book a brief commentary on Smethurst's work is given; and apologies are expressed on both sides for insufficient attention to the other's publication!

Many hands to hard work.

The books which I have covered (quite inadequately) by no means exhaust the range of material which has been appearing during the last few years. There have been many books recently on the nature, philosophy, influence, limitations, and so on, of science and also of philosophy, all of which are relevant. But in a review such as this it is impossible to range so widely! I should like to conclude by directing attention to several smaller publications pertinent to the subject of this review, i.e., several articles in magazines and journals. An excellent periodical, *The Christian Scholar,* has carried, very rightly, some of these contributions. One of these, by McShane (1954, p. 515), suggests that conflicts between scientists and theologians occur only when they stray out of their respective domains — not a very happy analysis, in my view. It would appear that McShane is an "optimist." Another essay, by Joranson (1954, p. 523), discusses biology and man. Still another (1954, p. 247) is the article by Pollard (who is a Director of the Institute of Nuclear Studies at Oak Ridge) to which I have already made reference. This is a superb statement of our responsibility and opportunity as Christians living in a world of scientific humanism. It is written primarily with the mission of Christian colleges in mind, but its relevance is much wider: ideally it should be studied by every Christian student and teacher. A quarterly journal, *The Modern Churchman,* contained a contribution boldly entitled, "The Christian Challenge to Science," (1952, p. 195), a few years ago. This provocative article was by Claude Curling, a physicist; it calls for a "re-interpretation of human existence" (nothing less!). For, he believes, the altered conceptions of the nature of scientific knowledge today, together with our belief in God as Truth, open the way to a vast synthesis of our understanding of experience, scientific or religious. This is indeed a challenge to all of us. Finally, two very recent articles in *The Ecumenical Review* (July 1957) deserve

mention, one by Ingelstam (of Sweden), the other by Miller (of Harvard). The first of these mentions certain dangers resulting from the influence of science, such as increasing unfashionableness of spiritual values, and goes on to emphasize that scientists must be met half-way, not preached to from a pulpit. The second draws attention to an essential difference between science and religion in respect of mystery, which is diminished in the former, but vital in the latter. This particular theme has been elaborated also by Michael Foster, a philosopher at Oxford, in his recent small book *Mystery and Philosophy* (SCM Press, 1957). Miller also makes a concerned plea that we in the Church try to understand what it is that we are really doing and to explain this to modern man in terms he can appreciate. To get clear about what we are doing: this was one of Whitehouse's guiding principles. To speak to modern scientific man: this is what Karl Heim (and Bultmann) have specially intended in their writings. These are in fact constituent motives of all who have written on this subject. In recognition of the objective of their strivings and with a serious, genuine share in their concern for these problems it is for us as students to "read, mark, learn, and inwardly digest" what they have said.

The task of examining the relation of the traditional faith to the contemporary scientific situation is one which, as Mascall has well put it, "urgently needs to be undertaken from time to time." It is urgent because our witness to Christian truth demands this in any case. It is all the more urgent because of the particular lunacy of our contemporary situation when, with hitherto unprecedented powers of life and death in the hands of man, the nations are looking desperately to the acceleration of scientific and technical advance to save us. Whether we like it or not, science is a factor which is shaping our age. If we as Christians believe that the end of man is the glory of God, we must work hard to understand whether or not and if so in what sense science is alien to or contributory to God's purposes for man.

JOHN H. ROBERTSON.

The Power and Limits of Science

By E. L. Caldin. London: Chapman and Hall, 1949.

Caldin is a British chemist concerned about the contemporary belief in "the unlimited applicability of scientific methods." In this volume he 1) describes the methods of science and discusses their limitations and 2) defends the validity of other rational but non-scientific approaches, particularly in metaphysics and ethics. In the first of these tasks he is more convincing than in the second.

The first half of the book delineates very adequately the method and scope of physical science itself. Any field of investigation is characterized by the study of a particular kind of object from a particular point of view which determines its method and the type of knowledge it can provide. Physics, it is suggested, studies

inanimate objects by quantitative measurement and the generalization of empirical laws. The roles of "models," conceptual schemes, and the scientist's imagination in the construction of theories are clearly presented. The use of analogies is illustrated in the wave-particle representation of light. Caldin holds that theories are not copies of nature; they are "constructions of the mind, but with this foundation in reality that deductions from them agree with empirical laws derived from experience."

A realist epistemology is outlined in which truth is defined as "correspondence with reality." Only minimal propositions about sense-perceptions as experienced can be considered certain, but when these are interpreted as signs of external "things," unified structures of interpretation can be developed, though never unambiguously. Thus though truth is defined as correspondence, it must be tested by consistency (coherence); simplicity and communicability are rejected as criteria, though they add to convenience of manipulation.

The justification for inductive reasoning is analyzed in detail. What is the basis for reasoning from particular observations to general laws? Views that the status of induced generalizations can be reduced to a probability of validity, to logical certainty, or to a shorthand fiction are successively rejected. Caldin contends that induction requires the metaphysical presupposition that there is *order in nature;* only if we take the limited data as signs of a regularity in which we believe on independent grounds will we seek for general laws. The discussion fails however to distinguish between the necessary conditions for the historic rise of science, for which such extra-scientific presuppositions were essential, and the contemporary situation in which the scientist may view the massive evidence of regularities exhibited by various areas of science as itself a basis for confidence in the orderliness of relationships. Perhaps the role of induction by simple enumeration is also overemphasized to the neglect of the importance of deductive confirmation.

The second half of the volume defends the validity of rational but non-scientific methods in metaphysics and ethics. Throughout it relies on Thomistic philosophy for both basic approach and illustrations. Thus as the example of metaphysical reasoning, we have a presentation of Aristotle's four types of cause with no attempt to relate these categories to the discussions of the concept of causality in more recent philosophy or its relation to science. "A substance," we read, "is something tending towards its natural end or fulfilment, with spontaneous activities bringing about that fulfilment as far as circumstances permit." Ethics consists in "acting in accordance with man's nature," the fulfilment of man's potentialities of which rationality is pre-eminent. The cosmological argument for the existence of God as First Cause is presented in an Appendix. We have a convenient summary of aspects of Aristotle's metaphysics, but a presentation unfortunately in dialogue with neither biblical religion nor modern science.

Emphasis on rationality as a central aspect of the good life leads to an interesting stress on the value of the scientific enterprise as one version of the rational life — a refreshing change from the common justification of science by its contribution to material welfare alone. Tolerance and respect for truth are pre-conditions of science and are in turn furthered by it. But science is only *one* form of the rational life and is not competent in areas such as evaluation of the ends of society. The principles of rational life, grasped through practice of one form of it, can be "adapted" to other studies and to life in general, it is maintained.

Caldin has a strong sense of the hierarchy of different levels of existence (inanimate, animate, rational beings) which allows him to make a clear separation of the roles of science and metaphysics and to avoid the dangers of reductionism. But one misses discussion of the relationship between these levels, which seem to exhibit continuity as well as distinctiveness, or of the problems arising when two disciplines study the same object. It is surely too simple a territorial division between psychology and philosophy to say: "Empirical psychology deals with the sub-rational in us . . . None of these (sciences) deals with rational action as such; that requires a separate study which is precisely moral philosophy." If we differentiate not the objects of study but the methods used, his epistemological discussion leads to an excellent delineation of the limitations of science. It remains for someone who shares Caldin's breadth of interests and faith in reason to extend the analysis to deal adequately with the role of religion.

Ian G. Barbour

Science and Christian Belief

By C. A. Coulson. Chapel Hill, N. C.: University of North Carolina Press, 1955. 127 pages, $2.50.

This book is the published edition of the 1954 John Calvin McNair Lectures on Science and Religion of the University of North Carolina. Published in 1955, it won the LeComte du Nouy Award that year for the best book relating science and the fundamentals of Christian faith.

The author, a mathematical physicist, is the Rouse Ball Professor of Applied Mathematics at the University of Oxford. The organization and content of the lectures have been altered only slightly for publication. The first and second chapters correspond to the first two McNair lectures and chapters III and IV to the final one.[1]

[1]As an historical footnote to this volume, the reviewer recalls that the first question asked Professor Coulson at the conclusion of his first McNair lecture came from a peppery, white-haired lady locally famous for getting visiting lecturers one-down. She asked Professor Coulson his views on the Virgin Birth!

In his first chapter, "The Challenge of Scientific Thinking," Professor Coulson tries to establish that it is possible to hold Christian views in a scientific age with "complete mental integrity." He points out the historical fact that science evolved in the Christian West and that it is only since the atomization of knowledge caused by intensive specialization that Science and Christianity have become separated. He points out three tendencies within the church which have tended to increase the separation: 1) clinging to the past, 2) taking refuge in metaphysics, and 3) acceding to the temptation to divide human experience into scientific and religious spheres. This last tendency has been most deleterious, in his opinion, because the Church has been forced to relinquish most of its claim over the lives of men, as science has moved into one area after another of human experience. Finally, Prof. Coulson points out why popular pulpit props such as Heisenberg's Uncertainty Principle and Rhine's Extra Sensory Perception are *not* proofs for the existence of God, and the dangers of assuming that they are.

In his second chapter, "Scientific Method," the aim is to answer these questions: "What is Science trying to do? What does it mean by truth? What presuppositions or attitudes are involved in the practice of Science?" This chapter is clear and powerful and rings true to the thoughtful scientist. He points out that Science is a strictly human enterprise, that scientific laws are, in reality, human constructs, and that Science grows by the "progressive building of grand conceptual schemes." Man's real view of 'scientific law' is shown to be an operational one by his willingness to modify 'law' when exceptions occur.

He points out that greatness in science, as in art, history or religion, consists in imagination. Truth in all these areas is not "acquisition of fact or increase of knowledge. It is the relationship between ourselves and some reality expressed and translated in terms of pattern." Science has "frequently (and erroneously) been described as if *(it were)* dull deduction from observed facts. Instead, like artistic creation, every real advance has been the result of a mental leap."

Prof. Coulson points out that (contrary to the belief of many scientists) Science has its own subjective attitudes and unprovable assumptions. The attitudes common to scientists include: integrity, hope, enthusiasm (often passion), personal identification with his work, humility, singleness of mind, co-operation, patience and judgment. The adoption of these attitudes by the scientist implies that he has made (or accepted) certain judgments of value which are based on moral convictions, however dimly glimpsed.

The three major presuppositions of science, without which scientific work would be impossible, are: 1) The unprovable belief that facts stand in relation to one another and cohere in a pattern, 2) the unprovable belief that there is order and constancy in nature, and 3) the unprovable belief that the basic laws of nature are simple, elegant, and beautiful.

It is then pointed out that such assumptions constitute the real links between science and religion. "If what I have said is in any real sense true, then science is only possible in a community where certain religious views are widely held." He concludes, "I asserted that, on the basis both of its actions and its search for truth, and of its mode of working and its presuppositions, science must be described as an essentially religious activity."

In his third chapter, "The Human Element," he examines the dual roles, as both actor and spectator, of man, the scientist. This chapter is lush with quotable epigrams and paragraphs. It is pointed out: "that man lives in two worlds (or perhaps more); and that there is a field, or world, of science in which questions posed in scientific terms get scientific answers; and another world, where words like belief, love, splendour and majesty have meaning. This other world refuses to be shut out of our experience; and if men try to do so, then even what they have discovered will be taken from them."

There are many alternative modes of description. Each of the disciplines, art, poetry, religion, history, science or philosophy, is a different way of looking at reality. One is not superior to another. They are complementary. Man can never, even partially, apprehend reality, and it is crass narrow-mindedness to refuse to consider more than one conceptual scheme. Both the Church and the Scientific Humanists at various times have been guilty of the sin of dogmatic over-simplification.

The relationship between science and religion is stated in this manner: "although science may be a religious activity, it is not a religion . . . Religion is the total response of man to all his environment. . . . By 'total' response we imply the response of his whole being, his body, his mind, his concepts, his emotions, his imagination, his human relationships. . . . It is by reflection that man makes this total response. . . . Thus the act of reflection is the putting together of two or more partial views: it is the connecting of religious activities with religion; . . . The act of reflection . . . is akin to the gaining of insight, a very different matter from the gaining of knowledge. . . . When a scientist asserts that he is not religious, we shall want to say of him that he has not, or cannot, make the full act of reflection."

Man is trapped by being both actor and spectator. A number of 'phantom problems' arise from this duality. It is man as actor who believes in free-will, as spectator who believes in determination. It is man the actor who conceptualizes 'mind.' It is man the spectator who conceives of 'matter.' Teleology is neither correct nor incorrect. It is an optional manner of viewing the natural order. However, unless the language of teleology is sometimes used, "we shall miss part of the pattern of nature shown by science."

In the final and most difficult chapter to bring off, Prof. Coulson proceeds through Natural Theology to Christ by analyzing the act of reflection. He docu-

ments the assertion that there is always a sense of 'given-ness' with a flash of insight. It is not something 'attained,' it is something 'revealed.' He points out the conviction of most scientists that nature is a 'whole,' and extends this conviction to include all patterns of thought, all disciplines. Then he asserts that this unity has a spiritual quality. The notion of incarnation is the only means of making sense of the grandeur of the world. But everything is 'given' in 'personal' terms. To understand 'things' in 'personal' terms revolutionizes one's outlook toward nature. The frustration of modern lives arises from failure to relate to the world in a sacramental fashion. It is Christ who puts a face on God and binds all nature and mankind into a single 'personal' whole.

This small volume impresses the reviewer (a physician largely unacquainted with the more extended studies of this type) as a masterful analysis of the relation of the scientist and science to religion. The analysis has been accompanied, astonishingly, with great clarity and without theological or philosophical abstractions difficult for the non-specialist. The real *tour de force,* to the reviewer, is the relating of the world of 'things' to the world of 'persons,' thereby establishing the necessity of personal religion and a sacramental view of nature. This accomplishment should be of great interest to a wide variety of scientists, but particularly to biologists, many of whom appear intuitively to have reached a position not dissimilar to the one rigorously expounded in this book.

John B. Graham

Contributors to Books and Publications Section

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THE GORDON REVIEW, Beverly Farms, Massachusetts

Bibliography on Science and Religion

(Prepared with the assistance of Drs. Donald H. Andrews, Ian G. Barbour, Mary E. Dumm, and John B. Graham.)

Accent on Form by Lancelot Law Whyte
New York: Harper and Bros., 1954, 196 pages.
This is Volume II of a series called *World Perspectives*, and it presents a fresh and illuminating point of view which is recognized as increasingly necessary for the understanding of basic science not only in biology but in physics and mathematics as well. The author ranges over the whole scale from microcosmic to cosmic, sometimes pure speculation, sometimes necessarily fleeting, frequently trail-blazing.

Atom and Cosmos by Hans Reichenbach
New York: Macmillan, 1933, 294 pages.
This was published in the surge of excitement which followed the great discoveries at the end of the first quarter of our century. Reichenbach writes with the authority of a master in the field jointly cultivated by mathematics and physics. He brings to bear an unusual and for that reason especially significant point of view, emphasizing the probability aspects. It is a little deep for the uninitiated.

Causality in Natural Science by Victor F. Lenzen
Springfield, Ill.: C. C. Thomas, 1954, 109 pages.
As an examination of the important problem of causality, especially in physics and biology and largely from the philosophical point of view, this short book summarizes the generally accepted ideas in a concise and (for some) rather technical way. It contains an extensive bibliography.

Christian Faith and Natural Science by Karl Heim
New York: Harper and Bros., 1953.
A leading German theologian, familiar with the literature of contemporary physics, outlines a metaphysical scheme based on the concept of "spaces" in relativity. This concept allows the representation of the non-objective sphere of selfhood, emphasized in Heim's existentialist orientation, as a different "dimension" of existence. It also provides a new symbol for interpreting the meaning of God's transcendence. (Reviewed in *The Christian Scholar*, September 1956, p. 229f.)

Christian Faith and the Scientific Attitude by W. A. Whitehouse
London: Oliver and Boyd, 1952.
The scientific attitude engenders a cast of mind, says the author, which, for all its nobility, includes a subtle predisposition away from certain essential features of Christian belief. It is not that science refutes Christian faith or undermines it, but the scientific attitude breeds a skepticism or indifference bordering on repudiation in regard to such matters as: a personal God seeks fellowship with his creatures, knowledge of him is our only real fulfillment, sin clouds our perception and thwarts our response. Despite his conviction that "a scientific attitude is no bar to the life of faith," the author emphasizes the difficulties.

Christian Theology and Natural Science by E. L. Mascall
New York: Ronald Press, 1956, 328 pages.
The author, trained in mathematics and now a neo-Thomist philosopher-theologian in Oxford, conceives the relationship between science and theology as requiring mutual help. "It is possible for theologians and scientists to engage in intelligent, good-humoured, and

fruitful conversation." His intensive pursuit of selected problems is intellectually invigorating and provocative. (Reviewed in *The Christian Scholar*, March 1958, p. 59f.)

Cybernetics by Norbert Wiener

New York: Wiley and Sons, 1948, 194 pages.

This was the first book to describe the new field of study of integrative relations which has become so important in so many different fields such as biology, communication, production engineering and all kinds of control work. The philosophical and metaphysical implications are deep. They are described here with some mathematics but with many pages which are very readable. It is an important book.

Human Destiny by Pierre Lecomte du Nouy

London: Longmans, Green and Co., 1947, 273 pages.

A noted experimental biologist faces the most profound and universal questions in a lucid way. Many disagree with some of his conclusions but he has catalyzed important discussion.

The Impact of Science on Society by Bertrand Russell

New York: Simon and Schuster, 1953, 114 pages.

This book deals with the effects of science upon human life with wit and clarity. Lord Russell discusses in turn science and tradition, the practical effects of scientific technique in an oligarchy and in a democracy, science and war, and science and values. In conclusion he considers the question, "Can a scientific society be stable?" He believes that science has and can continue to increase human happiness in many ways: for example, by diminishing poverty, by the growth of medicine, by increasing education, and by substituting observation and inference for unquestioning belief in authority. Unwisely used, science may intensify two ancient evils, tyranny and war. A scientific society can be stable given certain conditions: a single world government, a general diffusion of prosperity, a low birth rate, and opportunities for individual initiative. The fundamental obstacle to reaching these conditions is not physical or technical "but only the evil passions of human minds."

Life, Its Nature and Origin by Jerome Alexander

New York: Reinhold Publishing Corp., 1948, 278 pages.

A colloid chemist looks at the life process which has many colloidal aspects. He gives vivid illustrations to help the layman understand some of the more obscure features of the microcosmos. He has collected a wealth of facts to show where we have to start in our thinking about the nature of life.

Modern Science and Christian Beliefs by A. F. Smethurst

New York: Abingdon Press, 1957, 300 pages.

A widely inclusive survey of the relationship between Christian faith and the various sciences by a theologian, also trained in chemistry, who holds that they need never be in hostility. The pre-suppositions of science are theological in character, he argues, and science is indebted to Christianity for its use of ideas, and so science is founded at rock-bottom on Christian principles and cannot conceivably conflict with Christian belief.

Modern Science and Its Philosophy by Phillip Frank

Cambridge, Mass.: Harvard University Press, 1949, 303 pages.

As Frank says, he is a Doctor of Philosophy in Physics with the domain of his most intensive interest always in the philosophy of science, with science defined broadly enough to include much normally called humanities. This book is an authoritative exploration of this domain viewed with competence through philosophical as well as physical eyes. It

refutes many of the arguments of the so-called realists who are interpreting twentieth century science in a nineteenth century vocabulary.

Modern Science and Modern Man by J. B. Conant

New York: Columbia University Press, 1953, 187 pages.

The four Bampton Lectures for 1952 at Columbia University. A very engaging statement of the credo of an important scientist and educator with respect to both the nature of scientific activity and the realm of values.

Natural Religion and Christian Theology by Charles E. Raven

Cambridge: Cambridge University Press, 1953, 2 Vol. (Gifford Lectures).

A scholarly account of the growth of science in which the author rejects completely the idea that science and religion are incompatible and that their past quarrels need ever have taken place. He argues that, with the further development of biological theory, science is even now coming to an appreciation of the mysteries and unity of nature as religious in essence as any Christian could wish. See also his *Christianity and Science*, a brief restatement of these views.

Natural Science and the Spiritual Life by John Baillie

New York: Charles Scribner's Sons, 1952.

Based on an address given to the British Association for the Advancement of Science, this lucid little volume traces some historical relationships between religion and the rise of science. It is suggested that the new experimental approach was supported by the doctrine of creation, depicting a universe which is orderly and yet dependent on a free divine act and hence must be observed to be understood. Changing views of "explanations" in terms of efficient and final causes are presented, and the motives of scientific research discussed.

The Nature of Living Matter by Lancelot Hogben

New York: Knopf, 1931, 316 pages.

This is a discussion expanded from a short paper on a symposium program with Smuts, Haldane, Carr, and Eddington. It deals with vitalism, mechanism, and holism from a biologist's point of view — largely philosophic, little biochemical detail.

The Nature of Physical Reality by H. Margenau

New York: McGraw—Hill, 1950, 479 pages.

A comprehensive and systematic study of two related areas: (1) the implications of the distinctive theories of modern physics: thermodynamics, relativity, and particularly quantum mechanics. Probability-descriptions of atomic states are discussed in relation to the uncertainty principle and meaning of causality. (2) An epistemological scheme which sees scientific concepts as mental constructs created to interpret sense-data. These constructs must satisfy metaphysical requirements but are deductively confirmed by further relationships to sense-data. Subsequent discussion of this volume has centered around its identification of these constructs with reality: "According to our view reality changes when new discoveries are made" (p. 459). A concluding chapter leaves open the question of the extension of this methodology to other areas such as introspective experience or ethics.

The Nature of the Physical World by Arthur Stanley Eddington.
New York: Macmillan, 1928, 353 pages.
Based on the Gifford Lectures delivered in 1927; this book is truly a classic in content of ideas, presentation, and style. It is a model exposition of the universe we live in and the implications in the picture which we have of our surroundings and ourselves.

The New Physics by A. D'Abro
New York: Dover Publications, Inc., 1939, 961 pages.
This was formerly titled *The Decline of Mechanism* when published originally in 1939. It is essentially a review of modern physics for those with an almost professional knowledge of physics and mathematics. From it one sees the new view of the micro and macro emerge. This is a good reference book for the technical base of current scientific philosophy.

The Origin of Life by A. I. Oparin
New York: Macmillan, 1938, 252 pages. Translated by Sergius Morgulis.
This book by an eminent Soviet scientist is an impressive attempt to suggest how life may have come into being. It is necessarily highly speculative and can be judged only by how reasonably it conforms with established knowledge in the appropriate fields of scientific inquiry. The author supposes that an enormously long period of chemical evolution preceded biological evolution. Some acquaintance with biological chemistry is necessary to follow the author's argument.

Philosophic Problems of Nuclear Science by Werner Heisenberg
New York: Pantheon Books, 1952, 120 pages.
This is one of the best exposition of the philosophical implications in modern physics, together with penetrating comments on the vistas which are opened for thinking about its bearing on religion. Heisenberg is one of the foremost pioneering thinkers of our time and his conclusions should be respected.

Physical Science and Human Values edited by E. P. Wigner
Princeton: Princeton University Press, 1947, 179 pages.
Eight leaders in scholarship and research including Nobel Laureates examine the place and function of science in human society from complementary perspectives.

Physics and Microphysics by Louis de Broglie
New York: Pantheon Books, 1955, 282 pages.
In the foreword to this volume Albert Einstein stated: "This is a unique book." It was in the mind of de Broglie that the incredibly daring idea was conceived that all matter has the dynamic wave aspect and from this has been born the most radical intellectual revolution in five centuries. Although a good part of the book is physics as the title implies, it is non-mathematical and readable; beyond that, as not suggested in the title, de Broglie draws some of the most profound conclusions yet to appear concerning both the philosophical and religious implications in this new structure of ideas of which he is certainly entitled to be called the parent.

Physics and Philosophy by James Jeans
Cambridge: Cambridge University Press, 1944, 217 pages.
Jeans outlines clearly the questions which have been raised by the new physics of our century and offers many suggestive answers to these physico-philosophical problems which are still being warmly debated. He certainly does not give the last word, which he clearly never intended, but every word he gives is stimulating reading .

Reason and Nature by Morris R. Cohen

New York: Harcourt, Brace, and Co., 1931, 457 pages.

A professional philosopher looks at *life* and says there should be some other word for it; at least he finds unfortunate the romantic use of the terms *life, experience,* and *reality* as a by-pass for reason. This is a statement of the case for the reasoned approach to nature and shows how carefully one must use the word *reason.*

Religion, Science, and Society in the Modern World by Alexander D. Lindsay

New Haven: Yale University Press, 1943, 73 pages.

This volume is based upon a series of lectures delivered at Yale University on the Dwight Harring Terry Foundation for "Lectures on Religion in the Light of Science and Philosophy." The author, who is Master of Balliol College, Oxford, discusses religion and science in the modern world, the history of their present institutional forms, and the perils and hopes of the present (1943) situation. In the author's view, "the medieval system was destroyed on the ethical and political side by the Reformation and on the intellectual side by the rise of the applied sciences." The gradual disintegration and fragmentation of community life has led to a world without any clear sense of direction or aim. The task of the use of power to make men free by maintaining and increasing the common life of the community.

Religion and the Modern Mind by W. T. Stace

Philadelphia: Lippincott, 1953, 285 pages.

In this remarkable and provocative book the author analyses the disillusionment of modern man and traces this directly to the scientific picture of a mechanical world. Despite the scorn of an agnostic scientific age, he affirms that "religious feeling" is an essential element for human life, and thus he makes it clear that there has certainly been a conflict between science and religion and that it continues still. He devotes successive chapters to the consequences of the rise of science for morals, for religion, and for philosophy.

Religious Beliefs of American Scientists by E. L. Long

Philadelphia: Westminster, 1952, 168 pages.

A survey of the religious perspectives of a number of twentieth century scientists in the United States, organized by viewpoints running the gamut from fundamentalism to pantheism to naturalism, and noting particularly how each author relates his religious conviction to science. Major authors treated include: Einstein, Compton, Millikan, Mather, Lecomte du Nouy, Bridgman, Franck. The study concludes that scientists show the same variations in religious belief as do other groups and that they tend to compartmentalize science and religion or to subsume one category under the other rather than to keep them in dialectical interaction.

The Road to Reason by Pierre Lecomte du Nouy

London: Longmans, Green and Co., 1949, 240 pages.

Written seven years earlier than his better known *Human Destiny,* these are the words of a man who pioneered in exact experimental science and yet thought in terms beyond measure. It is a record of his personal search for understanding. It does not penetrate any new barriers but it should encourage others to try. It shows the need for reason in our time.

Science and Christian Belief by C. A. Coulson

Chapel Hill: University of North Carolina Press, 1955, 127 pages.

Science and religion cannot in the nature of things be contradictory; therefore they are

complementary, rather like the wave and particle theories of light. Christians must stop defending the "god of the gaps" attempting to prove God's existence by pointing to the yet unsolved mysteries of life, a god whose territory is diminishing with every advance of science. Let the Christians rejoice, says the author, for science is showing us something of God that none of his prophets have or could have conveyed to us. Cf. also his *Christianity in an Age of Science*, Oxford University Press, 1953.

Science and Christian Faith by E. L. Long, Jr.
New Haven: Haddam House, 1950.
Science and faith ideally should be in partnership but there are dangers in uncritical capitulation to the current scientific world-views. The author holds that interpretation is more ultimate than observation of fact and acquisition of knowledge at which science is unsurpassed; thus for true partnership scientific skill must be applied in commitment to Christ. An excellent book despite its small size and free use of clichés.

Science and the Christian Man by Charles E. Raven
London: SCM Press, Ltd., 1952, 40 pages.
One of the few men of religion who still can write with assurance as he gets close to science, Canon Raven examines certain basic Christian elements as they appear in the light of our scientific era. It is required reading (and interesting and thought provoking, too) for anyone who wants to view these problems in anything approaching total perspective.

Science, Faith and Society by Michael Polanyi
New York: Oxford University Press, 1946, 80 pages.
This is a printing of three lectures given at the University of Durham in which the distinguished author states the case for a faith affirmed by reason and essential for a free society. It is closely reasoned and compelling argument.

Science and the Human Imagination by Mary Hesse
London: SCM Press, Ltd., 1954, 171 pages.
She shows how the creative aspects of physical science have been very closely related to religious insight or governed by religious attitudes. But "there is no satisfying synthesis of science and Christianity this side of the Kingdom of God." Cf. review in *The Student World*, 1955, p. 204f.

Science and the Modern World by A. N. Whitehead
New York: Macmillan, 1925, 212 pages.
An analysis of the development of modern science and a criticism of scientific abstraction. An elaboration of the author's concept of organism which attempts to broaden scientific activity to include the facts of the perceived world.

Scientism, Man and Religion by D. R. G. Owen
Philadelphia: Westminster Press, 1952, 208 pages.
An excellent survey of the presuppositions of modern science, Marxism, and Freudian psychiatry, which traces the features of modern secularism back to their origin in the axioms of physical science.

Time and Eternity by W. T. Stace
Princeton: Princeton University Press, 1952, 166 pages.
The author is concerned with the conflict between religion and the philosophy of naturalism which many believe to be affirmed by science. He proposes that religious

thought and speech are symbolic and that a way is thus opened toward reconciling the two apparently opposed views. He brings to the argument the wisdom of a distinguished philosopher tinged with an oriental point of view, yielding original and suggestive ideas, not to be accepted completely perhaps, but not to be disregarded.

Time's Arrow and Evolution by Harold F. Blum
Princeton: Princeton University Press, 1951, 212 pages.
This book presents a careful analysis of the nature of the undirectional time factor both at the biological level (small space and time) and at the geological and cosmic level. It can be recommended as a solid preparation for those who wish to strike out into the more speculative implications of time and eternity.

The Transformation of the Scientific World-View by Karl Heim
New York: Harper and Bros., 1953, 262 pages.
Here Heim elaborates the religious significance he sees in the distinctive theories of contemporary science. He sees the downfall of relativity as another dethronement of man's false absolutes. The breakdown of causal mechanism in the Heisenberg Uncertainty Principle thrusts on us the burden of decision. The nature of miracles and of biological life are discussed. Each area of contemporary science brings man to a frontier where it is easy to raise existential questions, whose answers are not given by science itself.

Two Roads to Truth by Edmund W. Sinnott
New York: Viking Press, 1953, 235 pages.
An eminent scientist expounds the clarity of the relation between religion and science, which can be achieved through the attitude toward the universe and life derived from the significant mingling of Greek, Hebrew, and Christian roots. It is written with an unusual breadth and perception — historical, philosophical, religious, and scientific. It is well presented for the general reader.

The Unitary Principle in Physics and in Biology by Lancelot Law Whyte
New York: Henry Holt, 1949, 162 pages.
A discussion of the significance of form, especially its dynamism, as revealed in biological change and structure, this opens interesting philosophical vistas concerned with the meaning of the life process. Facts are arrayed in a stimulating pattern; conclusions not so much pave as point the way.

The Universe and Dr. Einstein by Lincoln Barnett
New York: Wm. Sloane Associates, 1948, 127 pages.
An introductory survey of the great physicist's life and work.

The Universe Around Us by James Jeans
Cambridge: Cambridge University Press, 1947, 289 pages.
Jeans is one of the two men of our century (Eddington the other) who were creative masters both at the specialized level and at the integrative level most significant for the intelligent lay reader. When first published in 1929 this was the outstanding book of its time presenting the vast canvas of space and its contents. It is still fascinating reading, though much has happened even since the recent editions.

The Voice of the Desert by Joseph Wood Krutch
New York: Wm. Sloane Associates, 1955, 223 pages.
This collection of essays reflects the enthusiasm and understanding of a distinguished naturalist for the sonoran Desert of Arizona. Krutch himself is at home in the desert,

and in this volume he inquires into the nature and habits of the other creatures, both plant and animal, who were there first. Besides being delightful these essays provide the non-technical reader with an excellent introduction to the theory of evolution, as presently understood, including examples of the available evidence and some interesting speculations about problems which are still unsolved.

The book ends on a philosophic note: to live successfully and happily we must be part not only of the human community, but also of the whole community of living creatures. Krutch communicates something of "the mystic of the desert," of the remarkable flexibility and adaptability of living things and a sense of the wonder and joy that it should be so.

What is Life? by Erwin Schrödinger

New York: Macmillan, 1946, 91 pages.

One of the half-dozen founders of modern atomics gives a brief review of the principal factors in the problem of the nature of the life process. He apologizes for "writing out of his field" but leaves no grounds for criticism in his careful, logical, and factual presentation with a thoughtful appraisal of the implications.

The World of Mathematics edited by James R. Newman

New York: Simon and Schuster, 1956, 2469 pages.

Sub-titled a small library of the literature of mathematics, these four volumes are a Kimberly mine full of diamonds which shed a sparkling light far beyond the domain of x and the n'th power. By a little judicious digging the reader will find a number of pages or even complete essays which contain not a single equation or symbol and which will be rewarding to the most humanly slanted interest. The closing essay by Stephen Leacock on *Common Sense and the Universe* is ten carat.

CONTRIBUTORS TO THE BIBLIOGRAPHY

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Reports and Notices

The Institute on Religion in an Age of Science

RALPH W. BURHOE

The age of science poses several crucial problems for Christian culture, of which we will here mention three.

1. The scientifically based technologies enable man to wrest from the earth such an abundance of foods and wealth of supplies, equipment, and power that men tend less to ask or to thank the Christian God for their daily bread, health, or protection against the dangers of the world about them. Even for what some would call the salvation of their souls men call upon the psychiatric technicians before the priest.

2. The technical developments that can carry the human body around the world in less than a day and the human voice in less than a second have brought the Christian face to face with the whole world of people, most of whom, he finds, do not believe as he does. Yet he finds them, whether Muslim or Communist, to prosper as well as he when they apply the new scientific technologies to oil or atom. Moreover he can convince but a tiny fraction of them of the validity or value of his Christian beliefs.

3. But perhaps the greatest problem of all is the tendency of the logic of the scientific ideas themselves to corrode and dissolve the strength of the Christian beliefs as they have been taught. Educational countermeasures seem only to delay the flood of the new ideas and their corroding effect on Christian faith. Moreover the growth of scientific ideas and their application are today accelerating and permeating the education and way of life of all peoples.

Recognizing these threats to healthy religious conviction and the related threat to healthy individual and social morale, a group of professional people in religion, science, and scholarship banded together in 1953 to establish the Institute on Religion in an Age of Science as a non-profit, religious, and charitable organization to work on these problems with the presupposition that the solution to the third problem is probably the key to the solution of all.

There are many ways by which men try to save the institutions and preserve the ideas they cherish, and there is no lack of Christian apologetics in the twentieth as well as in the first century. But many scholars, Christian and non-Christian, who are well aware of what happened in the first centuries, have seriously wondered how Christian beliefs will survive under the expanding impact of modern science which not only has revolutionized man's views of his world but his very status and nature in it. Some doubt whether any of the ancient religious traditions will survive for long, although it has been claimed that the Buddhist and Hindu traditions fit better than Christianity with modern science and will be nourished rather than withered by it. It does not seem that anyone, whether Roman Catholic or Protestant

Mr. Ralph Burhoe is Secretary of the Institute on Religion in an Age of Science and is the Executive Officer of the American Academy of Arts and Sciences.

(fundamentalist, liberal, or the new-orthodox), has been very successful in integrating scientific with religious beliefs since modern science began its rapid rise three or four centuries ago.

However this may be, the founders of the Institute on Religion in an Age of Science believe they see a new breakthrough to solution of the centuries-old problem of accommodating the religious tradition to the new knowledge, a breakthrough that is provided by recent developments in the sciences themselves. It appears to some of us as though a true harmony of the religious gospels with modern science is being opened up particularly by the new philosophy of science, the new analyses of the nature of knowing and the nature of reality or being, as well as by some recent positive justification of certain religious ideas by the sciences. And a number of America's foremost researchers in the physical, biological, psychosocial sciences and in the philosophy of science — most of them distinguished enough to have been elected Fellows of the American Academy of Arts and Sciences — have been investing much of their time, voluntarily and with enthusiasm, in the belief that this approach will bear fruit.

There is undoubtedly religious truth in the Christian tradition; and by religious truth we have meant truth about man's ultimate concerns, his highest values, the sources and goal of human life, man's relation to the determiner of his destiny, and the consequent necessities he must fulfil if he is to find more abundant life. The question we have raised is not whether there is such religious truth in the Christian tradition, but how an understanding may be gained which will enable men to render the underlying truth sensible and useful within the frame of reference of contemporary knowledge.

This approach to an understanding of Christian beliefs incidentally holds a hope that most Christians have nourished in their hearts even when they have disagreed with one another most violently: the hope for a universal and truly catholic faith that binds all men in common brotherhood. Moreover, so it seems to many of us, it holds an even greater hope: that somehow all peoples of the world can be drawn to a common brotherhood by their recognition of a single law enjoining a common ethic for all men.

This task calls for an intensive search or research, requiring the participation of those who are acquainted with the best in the old as well as in the newer ways of conceiving or formulating truth. And while the task of this search is staggering in its complexity and confusion, our faith in it is reinforced by the faith that there is one and one only reality that rules all that is, a faith common to some theologians of old as well as to scientists today.

The Institute on Religion in an Age of Science has held five annual summer conferences of a week's duration with a limited attendance of about 200 persons on Star Island, off the Atlantic coast on the boundary of Maine and New Hampshire. The professional people have been about evenly divided among those in (1) religion, (2) science, and (3) laymen (including scholars, educators, lawyers, businessmen, etc.). The pro-

grams have featured primarily the contributions of scientists of all major fields to religious problems. Some of the papers have been published. The year-round secretariat of the Institute is at 280 Newton Street, Brookline 46, Mass. A number of small groups and a few larger single-day conferences of similar professional distribution have met during the academic year to engage in exploratory discussions of these concerns at Harvard, M. I. T., Boston University, and the American Academy of Arts and Sciences. Delegations of scientists have also responded to invitations to discuss these problems with the faculties of theological seminaries. As of now the Institute's activities are limited to occasional, voluntary gatherings; but a need is felt for more intensive studies to develop a more extensive and commonly acceptable conceptual scheme, which we hope to undertake as funds become available. In addition to more extensive interdisciplinary communication and study by at least a small number of scholars and creative thinkers, it is felt that a journal is needed to provide scholarly criticism and exchange.

It is our opinion that the most rapid progress toward a revival of more effective belief in some of the great spiritual teachings of religion required for the peace and survival of man in this new age can be made by seeking a very close integration with contemporary science. For this purpose we believe that this and other institutes should bring together men from all branches of learning to explore these possibilities in the confidence that the search for the whole truth will always benefit and never destroy what is good. New insights into the religious realities, the realities of utmost concern to man, as they are developed by such institutes should be published and tested. I believe that it is in this direction that lies the greatest hope for the spiritual insight and moral power necessary for man if he is to live under the new conditions brought about by science.

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Faculty Christian Fellowship

The new executive director of the Faculty Christian Fellowship is Keith W. Irwin. He will give leadership to studies exploring the relation of the Christian Faith to the academic disciplines and will co-ordinate the faculty work of various denominations.

Mr. Irwin received his A.B. from Cornell College, his B.D. from Garrett Biblical Institute, and at the present time is completing his Ph.D. in philosophy at the University of Minnesota. He has lectured in philosophy at Garrett, has served as Assistant Professor of Philosophy and Religion at Hamline University, and has been pastor of a Methodist Church. He has been a delegate to USCC general assembles and represented the USCC and the Methodist Student Movement at the General Committee meeting of the World's Student Christian Federation at Nasrapur, India. He is the author of several articles in *Motive* and *Intercollegian* and is co-author with Roger Ortmayer of the book, *Worship and the Arts.*

Student Volunteer Movement

The new general director of the Student Volunteer Movement is Douglas W. Cook. He will be responsible for a wide fellowship of students committed to the mission of the Christian Church, and he comes to SVM at a crucial time when it may join in the proposed National Student Christian Federation.

Mr. Cook is a graduate of the University of Wisconsin and Garrett Biblical Institute. He has been pastor of Methodist churches in Wisconsin and of the Wesley Foundation at Yale University. His keen interest in the work of the SVM and the world mission of the Church shown there well prepares him for his new responsibilities.

Department of the Ministry

The new executive director of the Department of the Ministry is Graydon E. McClellan. He will lead the department in stimulating study of the theological foundations of the Church's ministry, administering various projects for the improvement of the ministry, and giving vocational guidance to young people interested in all church vocations. Mr. McClellan received his A.B. from UCLA and his B.D. and M.A. from San Francisco Theological Seminary. During the past year he was a member of the Program of Advanced Studies at Union Theological Seminary in New York while preparing an historical study of religious liberty in America. He has served as a social worker and as pastor of two Presbyterian churches in California. He has been a member of the board of trustees of San Francisco Theological Seminary and represented the Presbyterian Church, U.S.A. on the General Board of the National Council of Churches.

Religion in the State University

As part of the Centennial Celebration of Student Religious Activities at the University of Michigan, there will be a National Consultative Conference on Religion in the State University at Ann Arbor, November 17-19, 1958. Two books have been published in connection with this celebration: *A Century of Religion at the University of Michigan* by C. Grey Austin and *A History of Religious Cooperation in State Universities* by Seymour Smith.

Bibliographies

The first project of the Institute of Higher Education at Teachers College, Columbia University, is the compilation of an annotated bibliography of the literature relating to liberal education in the professions. In preparation for the forthcoming volume, the Institute has issued mimeographed copies of "Bibliography on Liberal Education and the Law" and "Liberal Education and Medicine: a Bibliography," which are now available without charge. Requests for the two bibliographies should be addressed to Mr. Earle J. McGrath, Executive Officer, Institute of Higher Education, Teachers College, Columbia University, New York 27, N. Y.

World Order Conference

"Christian Responsibility on a Changing Planet" will be the theme of the fifth World Order Study Conference sponsored by the Department of International Affairs of the National Council of Churches. Delegates will meet in Cleveland, November 18-21, 1958, to study these subjects: Theological and Moral Considerations, The Power Struggle and Security in a Nuclear-Space Age, Overseas Areas of Rapid Social Change, The Changing Dimensions of Human Rights, International Institutions and Peaceful Change, Missions and International Relations.

Political Science

Duke University announces a number of projects designed to promote research in the relationship between Christianity and politics. Director of the program will be Professor John H. Hallowell, chairman of the Department of Political Science of Duke University.

Graduate Fellowships in the Department will be provided for a course of study leading to the Ph.D. degree in political science with minor work in Christian ethics and theology. The fellowships are designed to attract students who have an interest in exploring the relationship between politics and the Judaeo-Christian tradition. The stipend will be $2600 and may be renewed.

Summer research conferences will enable younger faculty members of departments of political science and departments of religion to engage in research in this field. Post-doctoral scholarships of $700 each will be available for about eight persons each summer. The first conference was scheduled for the summer of 1958 and addressed the question: "Does Democracy Require Theological Foundations?"

In addition an annual lecture series on some aspect of the relationship between religion and

politics will be established. These lectures will be given by a distinguished philosopher, political scientist, theologian, or historian.

The whole program is provided for three years by a grant from the Lilly Endowment, Inc.

The Creative Arts

A conference on "Christianity and the Creative Arts," Oct. 31 - Nov. 1, 1958, is being sponsored by Gordon College. It will be for Christians who are professional artists, writers, actors, faculty in these disciplines, and students preparing for careers in the arts, to enable them to discuss mutual problems in the relation of their faith to their work. The program will include addresses, exhibitions, and seminars on the novel, drama, music, the visual arts, worship and the arts. For registration or information write to Dr. Charles A. Huttar, Gordon College, Beverly Farms, Mass.

Academic Freedom

The American Association of University Professors is inaugurating a program to augment its procedure of censuring institutions which appear to violate the principles of academic freedom. It is establishing an Academic Freedom Fund to make temporary financial aid available to teachers who are discharged or suspended without pay in apparently clear violation of their academic rights.

THE REVIEW OF METAPHYSICS

A Philosophical Quarterly

Volume XII Number 1

September 1958

ARTICLES

Norman Russell Hanson, **On Being in Two Places at Once.**

Henry E. Kyburg, Jr., **The Justification of Deduction.**

Joseph Margolis, **The Mode of Existence of a Work of Art.**

Charles Hartshorne, **Metaphysical Statements as Nonrestrictive and Existential.**

Robert Sternfeld, **Reason and Necessity in Classical Rationalism.**

CRITICAL STUDIES

Henry W. Johnstone, Jr., **New Outlooks on Controversy.**

George Burch, **Recent Vedanta Literature.**

Andrew J. Reck, **Insight and the Eros of the Mind.**

EXPLORATION

Michael Kullman, Charles Taylor, **The Pre-Objective World.**

DISCUSSION

Daniel Kubat, **Franz Brentano's Axiology: A revised conception.**

BOOKS RECEIVED

Robert F. Tredwell and Staff, **Summaries and Comments.**

DOCTORAL DISSERTATIONS, 1958

ANNOUNCEMENTS

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Back Issues

The following back issues of *The Christian Scholar*
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the life and mission of the church

The World's Student Christian Federation has undertaken to devote its life and work in the next several years to a program called the Life and Mission of the Church Project.

What is the Project about?

—— *a recall to obedience* to Jesus Christ, who always asks for our obedience at particular times and places.

—— *a recall to life* in the Church, that we take more seriously our own church membership and be awakened to new concern for unity, extension, and renewal of the Church in mission, especially in colleges and universities.

—— *a recall to mission* in the world, that we be drawn into the mission of the Church which exists in the purpose of God for the sake of the world, for the sake of the colleges and universities where we are.

—— *a teaching project,* to educate us that we may become living members of the body of Christ and convincing witnesses in the world.

—— *an ecumenical project,* whereby we may enrich each other across denominations and continents in receiving the new riches in Christ.

The United Student Christian Council and each of its constituent movements and agencies have given wholehearted endorsement to this project and have agreed upon a common emphasis for each of the next four academic years:

1958 - 1959 *The Biblical Faith and the Calling of the Church Today*
1959 - 1960 *The Mission of the Church in All the World*
1960 - 1961 *The Mission of the Church in Higher Education*
1961 - 1962 *The Task of the Church in North America*

For further information write to: United Student Christian Council
257 Fourth Avenue, New York 10, New York

SECOND QUADRENNIAL CONVOCATION

OF CHRISTIAN COLLEGES

Drake University, June 22 - 26, 1958

a convocation of representative persons from the protestant colleges in america, for the dual purpose of affirming the vocation of the christian college and studying its role in the mid-twentieth century.

The following study materials were used by delegates to the convocation for preparatory study and are still available.

Advance Study Commission Reports (set of six)	$1.00
The Life and Mission of the Church (WSCF)	$ .25
The Theological Idea of the University by George H. Williams	$1.00
What is a Christian College? ed. by David B. Sageser	$ .50

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